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PROBLEMS BEFORE ENGINEERING TEACHERS.

FOREWORD BY THE PRESIDENT,

A. A. POTTER,

Dean of the Schools of Engineering, Purdue University.

When an organization such as the Society for the Promotion of Engineering Education has survived for nearly a third of a century there is usually some good reason for its existence. Wisely from the very first our Society has given major attention to good teaching and has encouraged the adaption of engineering education to the needs of our industries.

The year 1924–25 marks the beginning of the second century of engineering education in the United States of America. The first institution in this country to give engineering instruction other than military, the Rensselaer Polytechnic Institute, opened its doors in 1824. The rapid growth in the number and enrollment of engineering colleges during the past century is partly the result of distinct public demands for engineering knowledge but is mainly due to the fact that the engineering curricula have been training men in accurate and scientific methods of thought.

During the first century of their existence the engineering colleges of this country have added much to engineering and scientific knowledge, have played a major rôle in breaking down the prejudice of the public against college graduates and have to their credit as their most important product thousands of men who can think, who have outstanding qualities of character and who have the ability and willingness to do useful work.

What major problems should concern engineering teachers in 1924–25? A few are suggested below:

1. Are we satisfied that our teaching methods are resulting in giving every one of our students an opportunity to be-

come as great and as useful a member of society as his abilities will permit? Are we providing for the training of the exceptional student for greater service? Are we serving the needs of the slow but earnest student?

Better teachers, self analysis on the part of every teacher, greater familiarity with the talents of the individual student and frequent discussions of teaching problems will do more to improve the quality of the output from the engineering schools than modifications in the curricula.

The sections and branches of the S. P. E. E. were set up mainly for the purpose of improving teaching methods. Are we making sufficient use of these meetings for the informal discussion of teaching problems?

2. Are we in danger of being unduly influenced by outsiders to lower our standards or to substitute popular elective subjects for our rigid prescribed scientific and mathematical curricula? The majority of the critics of engineering education are basing their advice on their personal and too often rather limited experience. Nothing would more speedily destroy the respect of the public for engineering education than a reduction in the amount of mathematical and scientific requirements or the substitution of an elective curriculum for the present prescribed engineering courses of study.

3. The engineering teachers have an unusual opportunity, through coöperation with our Board of Investigation and Coördination, to make a scientific study of engineering education. To what extent are the engineering colleges and the individual teachers assisting the Director of Investigations? Each engineering college should have several active committees at work on problems which have as their purpose the improvement of the output of our engineering schools. It is only through the active coöperation of all engineering educators that the Board of Investigation and Coördination will be enabled to make the progress which the importance of the problem merits.

The accomplishments of the engineering educators during the past century have contributed fully as much as any other

field of education to human happiness and comfort. The opportunities for self analysis and improvement afforded to engineering education by the Board of Investigation and Coordination should enable us to do greater and better things in the future for those who are preparing themselves for the engineering profession.

THE BACKGROUND OF THE BOULDER MEETING.*

BY O. J. FERGUSON,

Dean of the College of Engineering, University of Nebraska, and Vice-President of the Society for the Promotion of Engineering Education, 1923–24.

When 365 people congregate from thirty-eight of these United States, from Canada and Hawaii, for a series of serious sessions, there must be something back of it. When those same 365 people separate with regrets, with gripping handclasps and with an eye-to-eye gaze which holds, we are confirmed in our belief that there is an entity to the drawing and binding force. When those who leave take lingering looks around before departing, when backward glances are cast toward the receding landscape, when darkness cannot hide, nor distance carry beyond the horizon the scenes of those few days,—then we begin to sense what has been happening. Thus has the Boulder annual meeting impressed us.

The Society for the Promotion of Engineering Education is a very democratic body. Nevertheless, it is closely knit together by bonds of definite and well-recognized purposes, and by mutual appreciation of its members. For the thirty-second time has the society met in annual convention. Some of the most constructive work done in the field of education has been initiated and carried through by its efforts. Its current plans for investigation and coördination of the elements of engineering education are the most ambitious it has ever contemplated and are difficult not alone of definition, but even of conception. They continue to form and re-form as they take shape. Our outlook in this endeavor is peculiarly well typified by the convention address of Mr. Charles C. Gates, of Denver, in his description of the industrial development of the West. We

* *The Colorado Alumnus*, Vol. XIV, No. 5.

are in pioneering work with unmeasured and almost unlimited possibilities. Nearly every phase of engineering education lies open before us as a fruitful field for investigation. Our achievements will be limited only by our powers to conceive and coördinate. Could a better background than Colorado be had for the further unfolding of such plans?

No convention transpires for which the setting is negligible. The comfort and pleasure of the individual in his work are dependent upon the possible relaxations which may punctuate his labors. Nor may these punctuation marks be all alike. Periods alone are too commonplace and calm. We need a few commas, interrogation marks, parentheses, and even exclamation points. Or occasional italics and capitals in the text afford relief. All these we had, but we had never before known how large a variety of such interrupters exists. May we not coin an anomaly and assert that certain of these punctuation marks must have been colloquial? Who else could have provided a mountain trout-fry in an equivalent of Boulder Canyon? Or a well-guarded night canyon drive alongside a roaring brook? And as to variations in the type itself,—where else would the Committee on English have felt vigorous enough to meet all the time? Or, still more impressive where else could a president have congregated his council at 7.30 a. m. on three successive days?

The campus of the University of Colorado is beautiful. Unless one has a too well developed artistic temperament he should be able to do great work there. Evidences of this were everywhere present, although the regular session had given place to the summer school, and the student body was decreased in size and fewer faculty members were on duty. There were a restful unobtrusive and even inviting atmosphere of culture a breadth of interest and a fellowship which make a strong appeal and point one to the noble task of humbly serving humanity. A beautiful campus, fine buildings and still finer people make the setting for the record-breaking convention.

The classic pictures taken, enlarged and tinted by former Dean Brockett, and now hanging in the Senate Room in Macky Auditorium, are particularly attractive. In their artistry they display elegance which delighted the visitors. Macky Auditorium itself is a beautiful piece of architecture and forms a fitting approach to this collection of gems.

Mr. Fine's description of "Rambles Through the Rockies," coming as it did on the opening night of the convention, would probably have broken up a less strong-minded group of men and women into scores of exploring parties, each person bent upon seeing for himself nature with all her Colorado allurements. Many did remain after the sessions were over to enjoy some of the experiences which come with idling and observing and dreaming.

Dr. Chace's organ recital was a wonderful performance and a glorious greeting. The whole-hearted words of welcome uttered by President Norlin gave us cause to think deeply of the possible place of the engineer as a humanist.

It is impossible to thing of this recent meeting as having occurred simply in the geographical locus, Boulder, Colorado, or upon the campus of the University of Colorado. The University is not the campus, nor is the city made up of streets and buildings. We have been in the minds and hearts of good people whose every effort seemed to be to further our comfort and seek our pleasure, and to do this in the quiet, modest fashion which makes the attention almost impersonal, and nearly eliminates the feeling of obligation. That this convention has had so pleasurable a background is not a fortunate circumstance,—it is the studied result of much labor on the part of our hosts. To whatever extent mere thanks will repay our obligation, they are tendered to all who have so fully given their energies for our comfort, entertainment and instruction.

A REPORT OF PROGRESS AND PLANS FOR FUTURE ACTION.

BY W. E. WICKENDEN,

Director of Investigation, Society for the Promotion of Engineering Education.

Aims and Scope.

From the outset this inquiry has presented a persistent alternative between one of organic character, and one of specific aims. By an organic inquiry is meant one which deals with the evolutionary development of engineering education and with its functional place in social and economic life. The term organic implies that this idea of function supplies the major premise with which to confront every problem of how to organize and how to proceed. As a safeguard against unprofitable scattering of effort the terms which the Society proposed and which the Carnegie Corporation accepted as a basis for financial support expressly direct attention to "the fitness of engineering curricula and teaching processes," but they emphasize with equal force that " the purposes and objects of engineering education" shall serve as the standards by which such fitness shall be tested.

It is not easy to fix upon a datum plane for such an inquiry. One adviser suggested that an effort be made to formulate a satisfactory philosophy of economic effort; then develop the function of engineering in this philosophic scheme; next consider how engineering effort should be organized for its most effective service—all as a preliminary to worth while thinking about the way to educate young engineers !

It was plain that some compromise was inevitable between any such philosophic scheme, which the rapid changes in the social and economic order forbid us to ignore, and the stern

fact that the assured life of this project is three brief years, with an element of contingency attached to two of them. Furthermore this is a coöperative undertaking, and the co-operators, who are both numerous and eager, are not chiefly philosophers concerned with a reshaping of society, but practical men faced with the insistent question "Where do we go from here?"

Prudence suggested working toward both the philosophical and practical ends from an intermediate starting point. Foundations and outlines were to be fixed on a scale such that the project might go on indefinitely, but the schedule of work should provide for the completion of specific parts of the superstructure of results within the three-year period of the Carnegie grant.

For convenience of operation and record-keeping the general program is being built up in unit projects under five general divisions, with corresponding index letters *A, B, C, D* and *E*.

A. Evidence to be Derived from the Experience of the Colleges and their Graduates.

Everyone who knows the engineering educators finds few revolutionaries among them, but many eager to extend a helping hand to evolution. It is a safe prediction that what is to come bears a logical relation to what has been and can be discovered in part in the experience of the colleges and of their graduates. Such evidence can be gathered from the one hundred and forty or more engineering colleges only by general coöperation. In visits to thirty-four institutions which the Director has made in his reconnaissance of the problem, there was met everywhere an eager willingness to begin at once to assemble this evidence. In fact, this eagerness became almost embarrassing in its proportions.

It soon became clear that this division of the program would need more continuous and detailed guidance than the Director alone could give without fatally neglecting the other divisions

of the project. This consideration has led to the appointment of an Associate Director in the person of Prof. Harry P. Hammond of the Polytechnic Institute of Brooklyn, who entered upon this work in June, 1924. The thanks of the Society are due to the officers of the Institute, particularly President Atkinson, for their generosity through which Mr. Hammond has been freed for a period of full-time service of fifteen months and for part-time service thereafter.

Mr. Hammond will take the initiative and the direct responsibility in those features of the program which are to be carried out by the active coöperation of the colleges. Specific suggestions as to the conduct of such work will go forward to the colleges in a numbered series, beginning on October 1, 1924, as rapidly as Mr. Hammond is able to shape up the details.

It is clear that some of the problems with which the colleges are to deal are objective and are to be approached by gathering evidence, while other problems are subjective and admit only of gathering judgments or opinions. Both types of inquiry must be provided for, as well as methods of concentrating and correlating into a consensus the material coming from many sources. Assistance in developing such a consensus from the masses of evidence and opinion and in interpreting these results to the colleges will be sought from special investigative committees of the Society at large. Contact between these committees and the coöperating agencies in the colleges will be maintained by Mr. Hammond. The Director will maintain intimate advisory contact with these activities and will assist in their inauguration in the field by visits to institutions in Canada, the northwest, the Pacific states, the southwest and the south in the fall months.

It has been recognized from the start that the United States Bureau of Education should be one of the most important coöperating agencies in drawing upon the experience of the colleges. Three important projects have been begun, two at the Bureau, and one by the Director's staff, on this

basis. One is a survey of requirements for admission and requirements for the bachelor's degree, or its equivalent, in engineering courses throughout the United States, which is under the direction of Dr. W. C. John. Advantage is thus being taken of Doctor John's experience in collecting and compiling like information concerning the requirements for the bachelor's degree in non-vocational colleges. The second is a summary of the number of first degrees granted at the completion of the several engineering curricula throughout the United States in each of a series of recent years, which is also going forward at the Bureau. The third is a study of the historical evolution of the content of engineering curricula and of the variety of curricula offered in a representative group of fifteen institutions which is being carried on by the Director's staff with assistance from the Bureau in obtaining source material.

It is worthy of repeated emphasis that this general division of activity, in fact the entire undertaking, is a sympathetic study of engineering education by its friends and not a hostile inspection of engineering schools by their critics. The danger in such a study is not that we shall be too radical, but that we shall fall into the temptation of rationalizing the status quo, that is of piling up plausible reasons for going on as we have been.

B. An Inventory of the Occupational Demands Confronting the Engineering Colleges.

Great interest has been created by the Bulletin of the National Industrial Conference Board on Engineering Education and American Industry, which was also presented to this Society as a paper by Mr. Lyford at the Ithaca meeting, under the title "Education for Leadership in Industry." The estimate there given of the number of men needed to supply supervisory and technical leadership for industry in the present decade, has created great interest in the problem of the occupational demand confronting the colleges. The Joint

Advisory Committee of the Conference Board and the Society is very appropriately carrying its studies of demand into greater detail through the several industrial group organizations of its constituency, beginning with the pulp and paper, rubber and textile groups. It is planned to extend this inquiry systematically throughout the industrial groups affiliated with the Conference Board.

The committee of the American Railway Engineering Association on Coöperation with the Universities has shown a very sympathetic attitude toward the suggestion that a similar survey be undertaken on behalf of the railroads. The National Electric Light Association has been similarly approached on behalf of the light and power industry. The joint council with the national engineering societies is interested in surveying those fields of engineering activity which are primarily on an individual or non-industrial basis.

While no one assumes that a complete inventory of demand can be made, the results of a survey of important parts of the field would be of unquestioned value. Not least among the ends sought is a quickened sense on the part of many industrial leaders of the great values to be gained by a positive program of recruiting and developing man-power for leadership from the engineering colleges.

It seems reasonable to anticipate a considerable increase in demands upon the colleges. As a measure of preparedness it may be important to make a survey of the capacity of the engineering colleges as now equipped, staffed and financed to supply men. The facilities of an engineering college are generally known to be of a relatively costly nature. If the demands call for expansion it may not be easy to convince the public or private benefactors of the need unless the evidence of the inadequacy of present resources to meet impending needs is conclusive.

C. An Inquiry into the Bonds which Exist and Should Exist between the Engineering Colleges and the Organized Life of the Engineering Professions.

The bonds which have existed have been bonds of sympathy, tempered by occasional friendly criticism, but they have not been notably constructive. In strictly professional fields of education, such as medicine and law, the accepted division of responsibility is that the profession in its corporate capacity defines the objectives and the schools determine the means. No such relationship has been evolved in the engineering field. The only continuing contact between the professional organizations and the schools has been through the student branches of the national engineering societies. These branches have been cultivated by the parent bodies rather more as feeders to membership than as effectual links with the educational process. As to the educational values of such branches, the situation has been characterized by Professor Kenerson of Brown after an investigation on behalf of the American Society of Mechanical Engineers as "artificial respiration administered by the faculty."

The reasons for the slender nature of these bonds are fairly obvious. One is found in the divided organization of the engineering profession and the divergent views as to the functions and standards of professional organization incidental thereto. A second reason is to be found in the zeal with which the engineering colleges, as inheritors of the traditions of the older arts colleges, have guarded their independence. A third reason resides in the fact that engineering colleges do not limit their effort to giving professional training. A fourth reason and one of much importance in the light of recent educational history in other professions, is that engineering education has at all times been notably free from the abuses of shoddy standards and of exploitation for private profit which would invite the professional body at large to undertake a clean-up crusade. In a simultaneous

gathering in New York the Democrats have just begun a campaign for a transfer of the four-year lease on the White House by adopting a platform whose essence, as Mr. Dooley puts it, is "We point with pride to the rottenness of the Republicans." This kind of prideful pointing to abuses in the educational history of other professions is not likely to win new laurels for engineering.

For a number of reasons no time has been quite so favorable as the present for a frank inquiry into these relationships. In the first place, the undertaking of this general project and the organization set up by this Society for the purpose, make it practicable for the engineering colleges to take the initiative in their collective capacity, a plan which allays suspicions that the independence of the colleges is being challenged from without. Secondly, the four largest national societies have had valuable experience in working together in a number of joint undertakings in recent years. Third, the tide of agitation and legislation relative to licensure for engineers has paused, at least temporarily, and has left in its wake a greatly heightened interest in the professional standing of engineering and in the terms of admission and professional recognition. Fourth, it is now possible to make a fair appraisal of the recent movement toward the standardization of educational requirements in medicine, law and dentistry, which has been so intimately related to critical educational investigations in these fields. Finally, the present project makes it possible to collect closely related information on the relations of engineering education to engineering organizations in Europe.

On the invitation of this Society the national engineering societies in the civil, mechanical, electrical, mining and metallurgical fields each appointed two educational councilors to advise with the Board of Investigation and Coördination. The Board invited the executive secretaries of these societies to act with its members and the councillors as a joint council on engineering education and professional life. Of the

twenty-three persons involved eleven represent the colleges and thirteen the professional societies, one acting in a dual capacity. It may be well to emphasize the fact that neither the Society in inviting this particular group of societies to name councillors nor the Board in establishing this particular conference body, have in any sense adopted a policy of limiting their contacts to a particular group of engineering societies. In the initial stage of this undertaking it seemed imperative to keep the conference group reasonably compact as well as representative and to capitalize the experience these societies have gained in working together.

As seems fitting in the circumstances, the conference group has assumed no authority beyond sponsoring a group of studies of equal concern to the colleges and to the engineering societies. The memoranda and reports growing out of these studies will be given wide circulation among all parties concerned and the freest possible expression of opinion will be invited. These memoranda will be compiled by the Director's staff under the advice of a small steering subcommittee. The schedule of topics to be covered has been outlined in the June (1924) Bulletin of the Society. The work is being pushed with vigor and a number of memoranda will appear in the early future.

D. Projects in the Theory and Technique of Education and Psychology.

It needs only a casual reading of current educational literature to discover how vast a volume of experimentation, testing and discussion is going on in the realm of educational technique. Aside from certain inconclusive experiments with mental tests as related to admission problems the results of which are as yet unpublished the engineering colleges as a group have been largely untouched by this movement. One recalls in this connection the New Testament advice to " test all things and hold fast to that which is good." To be true to his calling the engineer is to be both a tireless experimenter,

one who tests all things, and a judicious standardizer, who holds fast to that which is good. In the realm of practice he has done both conspicuously, while in the realm of education his experimenting has been timid and his tendency toward standardization, as revealed by the wide-spread copying of conventional models, pronounced. It is natural, perhaps, that experimentation in education should go with the rather indefinite objectives of non-vocational curricula. In a field where results are as sharply tested by experience as in engineering education there is a valid reluctance to trade solid values for problematic gains.

The details of a program of inquiry in this field are yet to be worked out. About half our problems seem to have their roots in the question of how to get and keep the right boys in engineering colleges. As long as sixty per cent. or more of our entering students fall short of graduation it is plain that there is much to be done in the field of more highly selective admission and more expert handling of the elimination process.

Can the colleges assume that their students have already been through a vocational sorting process or is the task one which the colleges themselves must assume? The selective process which brings the student to an engineering college operates at or near graduation from the secondary school. Can there be valid vocational guidance or educational sorting along vocational lines at this stage of maturity under present American conditions? On examination this appears to be a field where enthusiasts rush in, but where experts fear to tread.

A survey of contemporary opinion among competent psychologists reveals practically unanimous agreement that the foundations of maturity, knowledge of self, knowledge of different fields of human effort and stabilization of interest needed for valid vocational differentiation do not exist among the vast majority of high school graduates. Further opportunity for self-discovery and a broader outlook on life is

needed before an educational program of definite vocational aims can be attempted with confidence. The early years in college are apt to remain a sorting ground for some time to come.

The outlook for a scheme of selective admission to undergraduate vocational colleges, such as agriculture and engineering, which will compare favorably in effectiveness with the selective admission operating in graduate professional schools or those requiring two years or more of pre-professional college work is not at all promising. There are fairly definite indications that such pre-professional college work has been required quite as much to improve the selection of students to fit the sanctioned professional type as to improve the standards of educational attainment.

It is hoped that some start may soon be made toward determining the group of personal attributes which are most significant in predicting success in engineering study, and if possible, in predicting engineering achievement. If a half dozen really basic aptitudes could be identified and reduced to fairly trustworthy quantitative scales, with an objective technique of testing, it might be possible to determine from cases of known degrees of success the range of individual variation on such scales within which students could be classified as good risks for an engineering training. It would then be possible for a student who is contemplating an engineering course of study to submit himself to examination by a competent disinterested agency and be advised as to the odds favorable or adverse to his success.

While recognizing the great value of the group of attributes underlying engineering success which Doctor Mann formulated on the consensus of judgment of a large and representative group of engineers, it seems evident that this group discriminates little if at all between the qualities requisite for success in any field of human activity involving high intelligence and responsibility and those requisite for success in engineering in particular. Furthermore no scale of measure-

ments was evolved and no indication was given of the permissible range of individual variations.

This is a problem of manifold difficulties, some of which are psychological and some incidental to lack of agreement as to where the limits of engineering shall be chosen. It seems imperative that at least a partial solution should be found, if any substantial progress is to be made toward a more rational plan of selecting students of engineering.

No doubt the Society is keenly interested in the movement to which President Aydelotte and Dean Seashore are making such noteworthy contributions, toward putting the work of gifted students on a more individual basis. Keen interest does not imply wholesale assent or ready adoption of such plans, but a desire for critical evaluation under the conditions existing in the colleges of engineering. In such an evaluation there must be kept in mind the organic unity which is presumed to characterize an engineering curriculum, in contrast to the greater freedom of election in arts courses, also the scope for individual pace and excellence afforded by the great amount of project work in the engineering courses. The educational program of engineering is notably severe in its demands on time and energy. There has been an apparent necessity to resort to group morale to sustain this program where such great groups of students lack both inherited or inculcated intellectual traditions and a strong economic or spiritual urge.

E. Investigation of Engineering Education in Europe.

The debt of engineering education in America to Europe for early models is well set forth in Doctor Mann's report. Later evolution has been along lines which clearly reflect the characteristic contrasts in the economic and educational life of the two continents.

In Europe men have been relatively many and raw materials relatively scarce. High density of population and fairly uniform economic development over wide areas have min-

imized migration, except to newer lands. There has been no frontier such as that which so powerfully influenced American life in the nineteenth century. Limited economic opportunity and a stable stratification of society have tended to restrict higher education to the socially privileged and the intellectually elite. Engineering in Europe has felt a natural urge toward refinement of design, approaching close to theoretical limits, in its concern for economy of materials, but there has been little urge toward economy of labor.

America has always been and still is a land of abundant space, cheap and widely distributed raw materials, and relatively scant, but highly mobile population. Cheap materials and costly labor have been dominant influences in our industrial life. The life of the frontier bred up a race of self-reliant men, schooled in the art of ingenious contrivance rather than scientific refinements. The work of these natural innovators displayed a certain boldness of execution and of clever dexterity in replacing human labor rather than theoretical refinement or economy of design.

Our educational ideal has centered around the widest possible availability of opportunity, rather than its restriction to the elite. The result of the wide availability of engineering education at low cost and its close articulation with public secondary education has been that in recent years we have given this form of higher education to a much larger proportion of our population that has ever been the case in any part of Europe, pre-war Germany included. It is true, of course, that many men so trained were of mediocre gifts, that many men of all grades have not followed engineering in a narrowly professional sense, but all have been absorbed into our economic and public life and have richly leavened it with an attitude of expectant sympathy toward technological progress. No doubt this wide diffusion of engineering training has done much to uncover the latent deposits of engineering ability in American youth, carried over as an inheritance from pioneer life. To it also we must credit much of the

traditional American readiness to discard physically serviceable, but obsolete equipment and to accept innovations which promise economic gains.

It may be conceded that formal attainments, especially in mathematical theory and refined design, have been superior in the better schools of Europe, that their student bodies have been much more rigidly selected, that a larger proportion of their graduates have followed the strictly professional aspects of engineering, and that a higher proportion of the teachers of engineering abroad have been and are men of notable scientific attainments. Granting all that has been claimed for the formal superiority of European education, although it has probably been over-stated, it may still be true that American policies and standards have been vastly more advantageous to the economic development of the nation than a close adherence to European models might have been. At least, we have no grounds for undertaking a comparison of our experience with that of Europe under the spell of an inferiority complex. An attitude of superiority would be equally amiss.

The supplementary portion of this report deals with more specific questions. The material presented is purely provisional and is subject to correction and revision before being issued in its final form.

Requirements of Representative Engineering Curricula, Compared with the Requirements in Schools of Law and Medicine.

While it will require some time to complete the study of the evolution of engineering curricula, a by-product is now available which affords a basis of comparison between the requirements of representative engineering schools and those of schools of law and medicine. The engineering curricula under study are being analyzed to show the proportionate requirements of each year in four general groups, made up of fifteen subgroups as follows:

General Groups.	Subgroups.
A. Collegiate.	1. English.
	2. Other languages.
	3. Economics, statistics, etc.
	4. Other subjects relating to human nature and institutions.
	5. Mathematics.
	6. Physical sciences—non-technical.
	7. Electives in above groups.
	8. Physical and military training.
B. General Technology.....	9. Graphics.
	10. Shopwork.
	11. Engineering not in special field of the particular curriculum.
	12. General mechanics and hydraulics.
	13. Technical electives extending outside of special field.
C. Special Technology.....	14. Engineering subjects in special field of the particular curriculum.
D. Free Electives.....	15. Electives affording a choice between groups *A*, *B*, and *C*.

This classification is open to minor objections, such as including the shopwork of mechanical engineers under general technology, but it was chosen as a sufficiently definite basis to enable an intelligent clerk to handle the details. It was necessary to handle some details somewhat arbitrarily, such as including the chemical subjects of the first two years of chemical engineering curricula under physical sciences and chemical subjects after the second year under special technology. In the main, however, the classifications are probably subject to little dispute and the general groupings are not seriously involved. Summer work done on the campus or under regular instruction was included, with the result that the total requirements in a number of cases exceed four academic years. In the case of the University of Cincinnati it was arbitrarily assumed that the academic requirements, which are distributed over the greater part of five calendar

years under the coöperative plan, are in the aggregate equivalent to four academic years, although the number of clock-hours represented may fall below this equivalence. The entire group of institutions included in the larger study from which these results are drawn was carefully chosen to be representative historically, geographically and functionally of American engineering colleges, but the particular data selected for this detail are not presumed to meet this standard in more than a general way.

General Content of Engineering Curricula.

In the following tabulation the content of representative engineering curricula is divided into four groups, viz., collegiate studies, electives which may be chosen from any of the groups, general technological subjects and the special technological subjects which pertain to the particular division of engineering represented by the name of the curriculum. The unit employed is the equivalent academic year. The five-year courses at Missouri are shown for purposes of comparison but are not included in the composite values.

Civil Engineering Curricula.

(Units—Equivalent Academic Years.)

	College.	Elective.	Gen. Tech.	Spec. Tech.	Total.
Alabama P. I.	1.43	0.45	0.73	1.39	4.00
Case	2.04	0.00	0.88	1.46	4.37
Cincinnati	1.65	0.00	1.13	1.22	4.00
Cornell	1.23	0.22	1.28	1.28	4.00
Illinois	1.87	0.00	0.59	1.54	4.00
Lehigh	2.07	0.00	1.27	0.98	4.31
Missouri (4 yr.)	1.89	0.14	1.38	0.59	4.00
Missouri (5 yr.)	2.09	0.54	1.38	0.99	5.00
Purdue	1.97	0.00	0.84	1.44	4.25
Wisconsin	1.55	0.43	0.96	1.18	4.13
Yale	1.71	0.71	1.00	0.72	4.13
Composite	1.74	0.20	1.01	1.17	4.12

CHEMICAL ENGINEERING CURRICULA.

(Units—Equivalent Academic Years.)

	College.	Elective.	Gen. Tech.	Spec. Tech.	Total.
Alabama P. I.	1.94	0.21	0.78	1.08	4.00
Case	2.02	0.00	1.01	1.35	4.38
Cincinnati	1.87	0.00	0.98	1.15	4.00
Illinois	1.88	0.28	0.52	1.31	4.00
Lehigh	2.20	0.00	0.91	1.14	4.25
Missouri (4 yr.)	1.99	0.14	1.38	0.49	4.00
Missouri (5 yr.)	2.09	0.31	1.38	1.22	5.00
Purdue	2.01	0.00	1.02	0.97	4.00
Wisconsin	1.67	0.32	1.25	0.89	4.13
Composite	1.94	0.12	0.98	1.04	4.09

MINING ENGINEERING CURRICULA.

(Units—Equivalent Academic Years.)

	College.	Elective.	Gen. Tech.	Spec. Tech.	Total.
California	1.30	0.23	1.60	1.06	4.19
Case	2.15	0.00	1.08	1.14	4.37
Illinois	2.01	0.00	0.75	1.24	4.00
Lehigh	2.48	0.00	1.01	0.82	4.31
Yale	2.44	0.36	0.91	0.69	4.39
Composite	2.08	0.12	1.07	1.00	4.25

ELECTRICAL ENGINEERING CURRICULA.

(Units—Equivalent Academic Years.)

	College.	Elective.	Gen. Tech.	Spec. Tech.	Total.
Alabama P. I.	1.23	0.47	1.56	0.75	4.00
California	1.30	0.23	1.60	1.06	4.19
Cincinnati	1.70	0.00	1.01	1.30	4.00
Cornell	1.24	0.18	1.70	0.88	4.00
Iowa State	1.85	0.11	1.10	0.94	4.00
Lehigh	1.72	0.00	0.94	1.58	4.25
Missouri (4 yr.)	1.79	0.30	1.24	0.67	4.00
Missouri (5 yr.)	1.89	0.67	1.24	1.20	5.00
Purdue	1.80	0.23	0.91	1.07	4.00
Wisconsin	1.31	0.35	1.24	1.10	4.00
Yale	1.57	0.82	0.99	0.93	4.31
Composite	1.55	0.27	1.23	1.03	4.08

MECHANICAL ENGINEERING CURRICULA.

(Units—Equivalent Academic Years.)

	College.	Elective.	Gen. Tech.	Spec. Tech.	Total.
Alabama P. I.	1.27	0.47	1.22	1.04	4.00
Cincinnati	1.69	0.00	1.05	1.26	4.00
Cornell	1.24	0.18	1.70	0.88	4.00
Illinois	1.70	0.00	1.07	1.15	4.00
Lehigh	1.73	0.00	1.15	1.37	4.25
Missouri (4 yr.)	1.79	0.23	1.27	0.70	4.00
Missouri (5 yr.)	1.99	0.63	1.27	1.10	5.00
Purdue	1.75	0.15	1.05	1.06	4.00
Stevens	1.91	0.00	1.67	0.80	4.38
Wisconsin	1.45	0.21	1.49	0.97	4.13
Yale	1.58	0.55	1.08	1.09	4.12
Composite	1.61	0.18	1.28	1.03	4.09

COMPOSITE OF FIVE GROUPS OF CURRICULA.

	College.	Elective.	Gen. Tech.	Spec. Tech.	Total.
Civil	1.74	0.20	1.01	1.17	4.12
Chemical	1.94	0.12	0.98	1.04	4.09
Electrical	1.55	0.27	1.23	1.03	4.08
Mining	2.08	0.12	1.07	1.00	4.25
Mechanical	1.61	0.18	1.28	1.03	4.09
Composite	1.74	0.19	1.12	1.06	4.11

STATISTICS AND STANDARDS OF AMERICAN MEDICAL COLLEGES.

	1908	1913	1923
Number of Schools	152	106	80
Affiliations of Schools:			
Number with universities	81	75	60
Number with colleges	8	6	5
Number of independent or proprietary schools	63	25	15
Per cent. with universities	53	71	75
Per cent. with colleges	5	6	5
Per cent. independent or proprietary	42	23	19
Entrance Requirements:			
Number requiring 2 or more years of college	11	32	74
Number requiring 1 year of college	17	28	0
Number requiring 4 years of high school	24	21	6
Number requiring common school education	100	25	0
Per cent. requiring 2 or more years of college	7	30	92
Per cent. requiring 1 year of college	11	26	0
Per cent. requiring 4 years of high school	16	20	8
Per cent. requiring common school education	64	24	0
Graduation Requirements:			
Number requiring 4 years (9 months session)	21		
Number requiring 4 years (8 to 9 months)	46	94	74
Number requiring 4 years (7 to 8 months)	49		
Number requiring 4 years (not specified)	7		
Number of part time schools	7	10	6
Number without specification	22	2	
Per cent. requiring four years	81	89	92
Per cent. part time and unspecified	19	11	8
Enrollment and Graduates:			
Matriculants	22,602	17,015	17,432
Graduates	4,741	3,981	3,120

A REPORT OF PROGRESS.

Statistics and Standards of American Law Schools.

	1909–10	1919–20	1922–23
Number of Schools	124	145	149
Affiliations of Schools:			
Number with universities or colleges—			
State	33	35	36
Municipal	3	3	2
Roman Catholic	9	17	18
Other	55	54	54
Number with other organizations—			
Correspondence schools	4	1	0
Business schools	1	2	4
Y. M. C. A.	2	7	8
Independent	17	26	27
Per cent. with universities and colleges	81	75	74
Per cent. with other organizations	19	25	26
Entrance Requirements:			
Number requiring graduation from college	1	2	2
Number requiring 3 years of college	4	5	6
Number requiring 2 years of college	3	23	36
Number requiring 1 year of college	5	20	18
Number requiring no college work	111	95	87
Per cent. requiring 2 or more years college	6	21	29
Per cent. requiring 1 or more years college	10	34	35
Per cent. requiring no college work	90	66	65
Graduation Requirements:			
Number requiring 3 years or over	84	126	141
Number requiring 2 years	38	18	7
Number requiring 1 year	2	1	1
Per cent. requiring 3 years or over	68	87	95
Per cent. requiring less than 3 years	32	13	5
Enrollment	19,428	24,074	33,719
Per cent. in full time day schools			44.4
Per cent. in schools requiring more than 2 years college plus 3 years law	8.6	14.2	11.8
Per cent. in schools requiring a total of more than 4 academic years	12.5	23.8	23.7
Per cent. in schools requiring a total of 4 academic years probably less than			30.0

From the results presented it is apparent that the great mass of American engineering students receive very little less than two years of work which would be entirely acceptable toward a degree in practically any college of arts and sciences. No attempt has been made at an evaluation of the relative length of the academic year, of the relative number of credit units required for admission and for graduation or of the relative rigor or vigor of requirements in engineering and non-engineering colleges. Engineering teachers as a group would probably claim a somewhat higher rating for a credit unit in an engineering college, as well as for the volume of requirements, as compared with the typical college of arts and sciences. Whatever allowance is granted for these factors tends to bring the collegiate requirements of engineering courses closer to the two-year standard which is a requirement for admission to Class A medical schools and law schools.

There is little in these results to support the statement so often loosely made concerning the " highly specialized " curricula of the engineering schools. Once admitted to the law school the student studies only law, usually for a period of three years. Once admitted to the medical school the student devotes his entire time for four years to medical science and art. The two-year pre-medical curriculum to be pursued in college is approximately half prescribed and half elective. The prescribed subjects: chemistry, physics, biology and English are fully as technical as foundation subjects as the corresponding requirements in engineering courses, and the recommended subjects: comparative anatomy, psychology, a modern language and social science are scarcely, if any, less so. The pre-law student who does two years of general college work usually selects his subjects with a definite view of their foundation value for law. While the great majority of medical students take not less than two years of pre-professional college work, probably not more than thirty per cent. of American law students do so. The numbers of pre-law and pre-medical students who voluntarily take more than two

years of collegiate work are probably not greater than in engineering.

The characteristic differences between the prevailing educational standards in law, medicine and engineering are seen to be in the realm of the length, definiteness and severity of the purely technical training rather than in the realm of the collegiate foundation work or cultural requirements, whatever they may be.

There are a number of reasons why the first stage of professional training in law and medicine may appropriately be longer than the corresponding training of the engineer. Traditionally the young physician and the young lawyer begin as general practitioners and only in their maturer years and in a minority of cases evolve into specialists. The young physician is apt to enter individual practice after his internship and not to share the advantages of library, records, experience, standards and counsel afforded by a large organization or mature employers. The young attorney enjoys these supplementary educational advantages to a larger degree, but much less than the young engineer. In the nature of things it is possible more fully to reproduce the circumstances of professional life in a medical school with extensive hospital and clinical facilities and in a law school with ample library and near-by courts, than in any engineering school, no matter how advantageously situated.

Medical service and legal service conform rather closely to definite types and circumstances while the types and circumstances of engineering service are of unlimited variety. Beyond certain general foundations of knowledge, skill and habit of attack it is impossible to foretell the intellectual requirements which will confront the engineering student in after life. For the great majority of engineering students an effective professional training of greater extent seems to be dependent on the orientation to a more definite field of activity which comes with the first few years of experience after college. This problem is apparently not to be solved by merely keeping the average student longer on the college campus, al-

though this statement should not be interpreted as an answer to the question as to whether or not a longer time is needed to do honestly and well what is being attempted in the present curriculum.

If a more extended technical training is needed by a considerable proportion of engineering graduates, and there are good reasons for thinking this to be so, may it not be necessary to seek elsewhere than in the precedents set in other and unrelated professional fields for an example? Perhaps no adequate example can be found and it may be necessary to work out de novo a plan of supplementary specialized education for graduates who have had the experience needed to orient them to a definite field of activity and to enable them to discover equally definite educational needs.

The marked improvement in the standards of medical education achieved during the past fifteen years suggests to teachers of engineering that the increase or strengthening of educational requirements on the part of a large group of colleges is a matter for concerted action. Where individual initiative in lengthening courses has had feeble success, concerted effort by the schools, backed by the solid sanction of the major professional organization and by the financial resources of one or more great foundations has succeeded almost unbelievably.

It is the intention in later reports to bring to the attention of the Society not only the educational standards of other professions, but also the plan of organization and method of work among other groups of colleges for dealing with their collective problems.

What is a Profession and What does the Term Professional Education Imply?

The question "What distinguishes a profession from a business, a trade or any other form of vocation" is one for which an answer is being sought by the conference group representing the professional engineering societies and the colleges of

engineering. This group is concerned with the relations which may be developed to advantage between the schools and the organized life of the profession.

The search for an adequate definition of a "profession" has revealed three characteristic varieties. One man says it is all an *attitude of mind*, that any man in any honorable calling can make his work professional by an altruistic motive. Another says it is a certain *type of work*, the practice of a science or art which has come to be conventionally regarded as professional. A third says it is a special *order in society*, a group of persons set apart and specially recognized as charged with a distinctive social function, as the bar, the bench and the clergy.

Another source of confusion arises from the fact that some approach the matter from the viewpoint of the ideals which the professional group *profess* while others think only of the acts they *practice*. The problem here is akin to the contrast between one's conception of a religious system when judged by its tenets and when judged by the practices of its adherents.

The following summary is an attempt to formulate the consensus of opinion of a considerable group of writers on sociology, economics and professional ethics. While differences of emphasis exist among these authorities, none express or imply serious dissent from the following outline. All recognize that there are characteristic attributes of *individual* professional life and attributes of *group* professional life. These exist in combination, but there is a considerable variation in the emphasis given to one or the other.

I. Attributes of Individual Professional Life.

1. *A motive of service* which is exalted above considerations of personal gain—in the strict sense there are no profits in professional life.
2. *A motive of self-expression* which implies a joy in one's work and a single standard of workmanship—one's best.
3. *A conscious recognition of social duty* to be accomplished, among other means, by
   a. Sharing advances in professional knowledge.

b. Guarding the standards and ideals of one's profession and advancing it in public understanding and esteem.

c. Rendering gratuitous public service, in addition to direct professional services, as a return for special advantages of education and status.

II. Attributes of Group Professional Life.

1. *A body of knowledge* (science) and skill (art) of such extent and character that it cannot be readily picked up by a versatile amateur or laboriously acquired by an apprentice.
2. *An educational process* of professional aims, which implies the existence of professional schools or the equivalent.
3. *A standard of qualifications* for admission to the professional group, based on character, education and competency.
4. *A standard of conduct* in relations to colleagues, clients and the public, based on honor, courtesy and ethics.
5. *A recognition of status* by colleagues or by organized society, as the basis of good standing.
6. *Organization of the professional group,* based on common interest and social duty. (Not universal in the artistic professions.) While professional organizations restrict their membership by standards of qualification, they may not properly maintain the economic exclusiveness of guilds or trade unions.

The above summary is not intended to imply that professional men can be trained only in professional schools, but rather that an equivalent of serious study and reflection is requisite.

Comments on this summary are being sought from a wide variety of sources. All members of the Society to whom the subject is of interest are invited to contribute their ideas or criticisms. At a later date a revised summary will be published, together with a statement of its bearings on professional standing and professional training of engineers.

THE PUBLIC SERVICE ASPECTS OF ENGINEERING EDUCATION.*

BY P. F. WALKER,

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Every developed course of study in any division of applied learning should induce in the student a higher appreciation of himself and of the profession for which he is preparing. This does not need to take the form of an undue estimate of one's own importance as an individual, but it does mean a proper estimate of the part he is prepared to take in the world's work. It calls for an understanding of the place which his work occupies in the general scheme of things: how it fits into the processes by which mankind is developing this thing which we call civilization. Without this understanding he cannot justly appreciate his own work, or realize how he may make it count more effectively.

In inquiring into the ways and means for bringing about this condition, it may be wise at the outset to attempt to estimate the position of engineering as it is to-day, and as it appears to others among the various callings. It is a difficult matter to see one's self in the midst of his surroundings, because of his very nearness to them, and as a result we do not often make the attempt. Perhaps we are inclined to take ourselves at our own estimate—which is a dangerous thing to do. We frequently hear engineers complaining because others do not accept their estimate of themselves. Organizations of engineers these days are making attempts, laudable in the main, to show to the public that the group is capable of taking a larger part in public affairs. Results are being secured in this way, but there is the danger that some engineers will jump to the conclusion that recognition is due them

* Presidential Address delivered at thirty-second annual meeting at Boulder, Colo., June 1924.

for something which they do not possess. It is a young profession in the light of the correct meaning of the term, in spite of the fact that work of an engineering nature was performed many centuries ago by men who must have been possessed of a superior, if intuitive, understanding of some of the laws of physics. An editorial writer in a recent number of a popular periodical has this to say:

New conditions have produced new professions, such as engineering, with many others rapidly emerging. The more enthusiastic members of these newer occupations and professions announce that they are going to make over the world, produce a new and better society and set up higher standards than have been known before. They will contribute, no doubt, to the sum total of useful information, but technical facts will never serve as popular sustenance. The leaders of a nation must speak in very simple terms, loud and clear.

What are these conditions which have brought engineering into the status of a profession? In answering this question we may come upon an explanation of the function of the engineer's work in the developing order of civilization. It is not an academic question, but one filled with meaning. It touches not only engineering, but modern life with its troublous problems which are causing so much concern to-day. It is because these conditions have this widespread significance, touching human life in varied and vital ways, that we need to analyze them. They demonstrate the true nature of engineering as an intensely human activity.

Man has lived on this earth, in substantially his present physical form, for many thousands of years, but during only the last three hundred has he used his mind to reason by the scientific method, on the basis of accurately observed facts of nature's physical laws. Previously he had taken himself as a type and worked outward into nature from that viewpoint. In earlier epochs he ascribed human motives to many of the elements of nature, and even shaped the images of his deities to conform to himself. His philosophy was entirely speculative, even that of Plato and Aristotle. The supposed natural laws formulated by Aristotle would not square with

observed facts, when men finally came to observe with care. Religion as a profession, and law, developed under these conditions, as purely personal matters. Men thought in introspective terms, and became violently opposed to any other mode of procedure. Even the practice of medicine assumed proportions on the basis of the study of man alone, by empirical processes. Thus the three time-honored professions developed with an intense personal bearing, magnifying the motives and creations of the genus homo. True it was that men studied form and built many structures which endured, but practices depended upon direct observation. The ancient worker could not develop agencies outside of his experience. Greek learning did not go on after Aristotle. It was a finished affair, devoid of the stirring elements of life.

In the Mediæval period religious dogmatism controlled the lives and actions of men. Public enterprises were limited to churchly affairs, little being done to raise the standards of living or to advance secular learning. Civilization went to a low ebb and then recovered very slowly. Extreme prejudices in matters religious were developed, resulting finally in revolts which intensified the feelings and thoughts of men in spiritual affairs. The fine arts had their day, and a few discoveries in the useful arts were made, but these had no influence in guiding the thought of the period from the introspective course which it had taken. The significant thing about the period, so far as we are concerned in the present discussion, was that it determined habits of thought in those matters relating to man's inner nature, in ways that have persisted. Fifteen hundred years of that kind of teaching put a tremendous impress on humanity, and determined the basis on which motives are formed. It dealt with an intensely vital thing in life, contributing to forms, if not to the graces, of religion. It made religion a prominent factor in living, and men's minds have not relinquished the idea in theory, although some have in practice.

When active minds finally broke away from religious control over secular matters and began to experiment and find out

the laws of nature, the new thought was confined to the physical realm. Religious dogmatism went on unchanged for a time, and has yielded only by indirect influence. Ethical advances have not paralleled the advances in physical science from new and fresh lines of thought, but have come only as influences changing but slowly the mental concept. This is said with respect to the moral and ethical natures of men, and their attitude toward social obligations, rather than their theory of religion and personal spirituality. Man's conduct toward society as an individual having moral attributes, and his conduct toward science and business, have been molded by very different types of influences. The one is a continuation of the old introspective philosophy; the other is the scientific thought based on natural phenomena.

The scientific era began with the work of Galileo and Descartes, supplemented by the activities of Francis Bacon, in the latter years of the sixteenth and the early years of the seventeenth century. We may pass by with a mere comment the characteristics of their work in reference to the building up of a body of natural science, and think only of the influence which the new system had on the thinking of men. At the foundation is a constantly growing body of observed facts pertaining to the physical universe. From this mass of primary data there has developed the scientific system, so called. Progress was slow for many years after the work was started, but in the course of two centuries people became prepared for the forward movement which then came about from scientific discovery in lines capable of application in useful arts. The work of Watt, Faraday, Thompson, Stephenson, and Fulton, came after the ground had been prepared. Men were ready to accept the opportunities which were offered. Business interests had reached the point where new forms of power could be financed and made useful. The engineer came upon the scene, with a technical basis for his work and with a clientele ready to receive it. The physical machinery fell into position alongside of the economic, and the industrial revolution was on.

The mechanical inventions and the development of the principles of electricity, important engineering achievements as they are, were not the only forces tending toward industrial reconstruction. There had been two centuries of development of thought along scientific lines. The capacity to create, to adapt environment to the needs of man, and almost literally to remake the world, was rapidly developing. With such combination of influences, civil progress has gone on at an ever increasing rate. The means of transportation and communication have made government possible on a scale larger than ever contemplated in the past, by reason of which the capacity to organize for government and for business enterprise has had corresponding growth.

Under these conditions the engineering profession has developed. Out of the scientific thought of these last centuries there has been developed a body of principles and a literature which have established engineering as a science and given it a definite program. Its connections are rooted in the science movement, as the older professions are based on the character and creations of man. It deals with the inanimate forces rather than with human. Its laws are fixed, whereas the principles underlying the older professions are variable with the opinions and actions of mankind. Medicine, it is true, has been developed on a scientific basis, but it harks back to the older days when its connections were those relating strictly to human elements. Engineering comes purely from the scientific basis and did not come into actual form, with a supporting literature and definite procedure, until well on in the last century. In respect to both time and the nature of its basic foundation, it differs from the legal, medical, and ministerial professions. It serves mankind, but in an objective manner rather than in an intimate personal manner.

The same scientific influences, fostered by engineering activities, have been at the basis of our developing society. Governmentally, industrially, commercially, and in large measure socially, mankind has organized his forces under

these influences. The expansion in size and breadth of influence has been tremendous. Engineering deals with agencies employed by large aggregations of capital and with municipal and other governmental institutions. The individual citizen does not employ engineering talent, save as he represents large masses of capital. By this token, *engineering is the profession of organized social and economic forces in modern life. By nature and tradition it is associated with the public interest. Public service is its primary function.*

The individual engineer performing this service must be considered aside from the service itself. He deals with organized scientific principles in behalf of organized social forces, but he himself is a man—an individual in society. What about him, personally, aside from his ability to perform his technical task. People at large think of his work as influencing their group activities but not their personal lives, and note little concerning him as a person because they do not see him. He tends to become a person apart, associated with organized activity with specialized powers. His is a unique position in modern civilization. In every other recognized profession the service rendered touches the recipient in ways which appeal to the feelings and ideas fostered by sentiment and associations intensified by the individualistic teachings of mediæval and ancient philosophy, but appreciation of engineering service comes through logical thought processes in the field of science. Feelings come instinctively, but logical thought only through training. To paraphrase the words of the ancient prophet, the engineer is a man of science acquainted with grief.

This distinction does not, in reality, constitute a handicap to the engineer. To be sure, it means that some people do not understand just what his function is in the world, but he can well afford to wait. The direct trend in civilization is toward him and his point of view. He is working coöperatively with many other groups of men in science, business, philosophy, and letters to change the point of view. It has become possible for man to change his environment and to

adapt new forces to his own use. The only trouble is that these changes have been too rapid, and some have been unable to keep up the pace. Because of this, protests arise from those who have continued to think introspectively, so that we see such movements as are now sweeping over the country, opposing the teaching of evolutionary science in the schools and aiming to emphasize the so-called fundamentalist program in religious institutions. It is only a phase in the forward movement, not to be looked upon as retrogression at all, but simply the sounding of a note of warning to the science worker not to allow his enthusiasm for a newfound source of energy to blind him to the fact that mankind has a personal side to his nature which is calling for expression. At heart we feel that man is greater than his works. The devotee to science has been prone to neglect this, and to express his discoveries in language which wounds unnecessarily where more thoughtful words would enlighten and convince. Serious attempts are now on foot among the biologists and related scientists to carry a more constructive message to the public, but in doing this they must break down the prejudices which they themselves have created.

This experience carries a meaning for engineers. The language of professionalism need not be used on all occasions. The editorial writer who has been quoted is right. The leaders of a nation must speak in simple terms, and speak clearly. Our relations to society are clear enough when understood. To be sure we deal with institutionalized society rather than with individuals, but the people of America are largely institutionalized and know how to think in those terms. There is ample reason to believe that the American people are ready to-day to trust the judgment of the engineering profession on many of the most important questions which affect national development and national welfare. My own experience and observation with state and national groups during the past few years have led me to that belief, in spite of a few instances of political misdirection which indicate otherwise. The time is opportune for engineers to participate more defi-

nitely in public affairs, not as members of a newly organized group trying to take the reins and lead a nation out of bondage, but as helpful citizens who are trained to constructive effort, willing to work with others for the common good. There must first be developed by us an understanding of this fact, and then a cultivation of the habit of dealing with matters of public concern in language understood by others but expressive of the technical nature of the questions at hand. If ours is the profession of the organized social and economic forces of modern life, it is time that it be made to figure more strongly among the citizenry of the nation.

This thought comes back to our educational institutions with positive significance. We like to think that we are training men for leadership. We are. But primarily we are training men for service. Never in the history of civilization or of the United States has there been a greater need for men who think straight on the basis of constructive facts, and who also have an appreciative understanding of the motives and beliefs of mankind. Leaders do not come exclusively from the schools. They come from all ranks, from the palace and the hovel, from the hard school of experience and from the easier courses of training afforded by educational institutions. Leadership involves more than the capacity to pass prescribed courses, but foundations are laid in that manner. How well or how poorly laid is for us to determine. That is the reason for undertaking the investigations which are on our minds these days. As we think of these questions of contact with boys and with industry we must keep in mind the fact that engineering is concerned with the social and civic, as well as with the economic forces. We are working with plastic material which is subject to molding influences over which we have the control. It is not so much a question of curriculum as of teaching and personal contacts. Our students in their four or five years of school life are forming habits of thought as well as a working technique, and our engineering teachers exercise the most direct influence on their lives during that period. This is but natural, because the student's

primary impulse is to consider first those matters which, for him, are most closely associated with engineering activities. The courses which they take in the associated divisions of social science, where we send them for the elementary grounding in the humanistic subjects, usually bring them into contact with younger instructors. In the engineering branches they meet the more mature men from whom they gain their conceptions of the engineering profession. The responsibility for guidance is thus laid on ourselves, and there it rightly belongs. It means that we must gain for ourselves this view of the profession as one dealing in direct manner with those forces which are controlling the material and social development of mankind under the modern system, in order that engineering activities may be interpreted to these students in their true social significance. We are not teaching *engineering;* we are teaching *men.* The greatest thing which we can do is to produce men who think clearly and who have seen visions of life in its true proportions. The responsibility and the opportunity are ours. The engineering school has a task which may not be more vital or important than that of other schools, but it is a *different* task, having a particular bearing on social progress. It is invested with a public interest.

What we need to-day is a motive that will command the highest powers of which man is possessed. We rise to the higher levels under the impulse of feeling. Sacrifice is the expression of loyalty and devotion to the nation and to society. It is a development of the centuries, and of the instinctive tendency of men to cherish their own works. We *admire* the achievements of science but *love* our own institutions. It was Goethe who said that man changes but mankind remains the same. We are confronted with the necessity of reconciling the scientific world recreated by *man,* with the original world of *mankind.* Through science and engineering the nations have learned how to wage war efficiently, but they do not know how to live in peace without losing the spirit of sacrifice. Peacetime loyalty is as fine a thing as wartime loyalty, but somehow we have not made of it a living reality. The stand-

ards of public life are endangered. We are shamed at times by exposures of men who have not conceived of public office as a public trust, and are prone to lay the blame on those individuals, as though public servants were made of different clay than their constituencies and should act differently. But the true remedy lies farther back. A true record of the ways in which the rank and file of citizenship is devoting thought and personal influence to matters of public concern would not make an especially glowing picture if presented in actual colors. A higher type of citizenship is needed on the street, in the business house, in the factory, and in the professional office where constructive planning of private and public works is under way. More insidious than the danger of corruption in public office is the blunted vision of men in the private enterprises of the nation.

This is but saying in different words that all service is public service. If the aim of making it a living reality is to be accomplished, the means for doing it must be organized. There must be concerted action. The ground must be prepared, the seed sown. The colleges and universities of this country have reason to take heed. In too great measure they have become institutionalized and made to reflect the uncertain light of current habit and custom. We need to look to our ideals if we hope to point the way. It is not enough that a young man should have complied with purely secular and scholastic requirements to warrant our placing on him the stamp of fitness for work in an honorable and responsible calling. Character, and the realization that capacity to do carries with it a responsibility to society, are determining elements in effectiveness, and they must be given consideration. Engineering is the profession of the organized social and economic forces—the product of a century of scientific progress: then by that token it is the duty of these schools, charged with the development of its personnel, to hold true to the conception of service to those organized forces which are molding humanity. It means giving direction and tone to our work as teachers. If the ideal possesses us, the result is assured.

THE EVOLUTION OF ELECTRICAL ENGINEERING INSTRUCTION AS REFLECTED IN THE PAGES OF THE ELECTRICAL WORLD.

BY HENRY H. NORRIS,

New York City.

Former Secretary, S. P. E. E.

The writer recently had occasion to examine closely the files of the *Electrical World* for evidences of helpfulness to the cause of technical education. These evidences were found to be legion. One can trace step by step in the pages of the paper, as nowhere else, the progress of the art of instruction in electrical engineering. The editors gave space to descriptions of facilities for instruction, notes of current happenings, data as to registration, etc., commendation of what appeared to be wise tendencies and warnings where such seemed necessary. The debt of electrical engineering pedagogy to this publication, which has just rounded out its first half-century of service, is very great indeed.

M. I. T. Course Announced.

The *Electrical World* was founded in 1883 on a telegraphers' paper, the *Operator*, which had been started in New York City in 1874 by young Western Union operators. It is significant of the change in aspect of electrical development of the time that the issue of the *Operator* for December 30, 1882, the last, should contain an announcement of the establishment by the Massachusetts Institute of Technology of a four-year course in electrical engineering. The first issue of the *Operator and Electrical World*, that of January 6, 1883, stated that one special and five regular students were taking this course. The aim of the Institute was said to be not to give training in handicraft, but to give all students a general education in the application of science to industry, and individual students a special education in the application of science to special industries.

The Background of the First Electrical Engineering Courses.

The years 1883 and 1884 were important ones in electrical engineering, in education in this field, and in the development of the infant publication, which after a few months became, simply, the *Electrical World*. Fundamental inventions had been commercialized in the fields of telegraphy, telephony, arc lighting and incandescent lighting. Experiments had been made with electric railways. Camille Faure had greatly improved the methods used in making lead storage batteries. Chas. F. Brush, Thomas A. Edison, Elihu Thomson, Edward Weston, Elmer A. Sperry, C. J. VanDepoele, Frank J. Sprague and other American inventors, were applying vigorously the results of their researches. The whole electrical field was characterized by enthusiasm and productiveness.

Engineers tended to get together in societies of various sorts. The New York Electrical Society was formed in 1881, the Association of Railway Telegraph Superintendents and the American Street Railway Association in 1882, and the American Institute of Electrical Engineers in 1884. In 1884 a great international electrical exhibition was held in Philadelphia.

Colleges Prompt to Meet the Need.

This was the atmosphere in which technical schools, colleges and universities found themselves. Like the M. I. T., other educational institutions became actively interested in electrical applications. Cornell University started an electrical course in 1883, under Prof. W. A. Anthony. The *Electrical World* said that "Cornell is the first among our universities to organize a course in electrical engineering, and in so doing sets a good example to other institutions." In the same year the Stevens Institute of Technology decided to add a department of applied electricity to its organization and the following year appointed Prof. W. E. Geyer to the chair.

The leading editorial in the issue of the paper for September 8, 1883, dealt with "Educating Electrical Engineers." It said: "We now have the demand for a technical school which will graduate thorough electricians; we have the students in great numbers who desire such an education; and we have no public prejudices to overcome. . . . The science is extensive enough to occupy all the time usually spent in college. . . . Whether or no the science of electricity can be taught in college is a feature of the subject which has many strong advocates on both sides. . . . Some of our leading colleges have recognized this want and have devoted chairs to the science. . . . We cannot do better than to close by stating a remark credited to Mr. Edison. He said that he had tried the purely practical man without satisfaction; that the purely theoretical was not better; and that he now wanted a happy mixture of the two."

A few weeks later the paper expressed satisfaction that the Jefferson physical laboratory, auxiliary to the Lawrence Scientific School at Harvard, was under construction. This was in part to provide facilities for studies in electricity. Two weeks later similar information was given regarding the Sloan physical laboratory which was being built for Yale.

Electrical Engineering Not at First Distinct.

The *Electrical World* at this time commended the courses laid out at Cornell, Yale, Harvard, Stevens and M. I. T. in that they had arranged for instruction in electricity as part of a regular course. "In this country we have not fallen into the error deprecated and condemned by Dr. Siemens,* of regarding electrical engineering as an independent branch of science."

The cases cited will serve merely to illustrate the interest in electrical engineering education which was spreading rapidly

* Dr. Werner Siemens had criticized some German schools for establishing professorships for the purpose of educating a special class of engineers, viz., electrical engineers, showing misunderstanding of his earlier suggestions as to the importance of special instruction in this field.

throughout the country. The University of Liége, Columbia College (graduate department first, undergraduate later), Rose Polytechnic, the Ohio State University, The University of Michigan, King's College, London, the City and Guilds of London Institute, Princeton College, the University of Pennsylvania, and many others, soon became well known for their work in electrical engineering.

Manual versus Mental Training.

In some quarters there was in these early days a leaning toward too much practical work in the electrical course. The *Electrical World,* in warning against this, said: "No amount of practice at the lathe and forge will help the student to comprehend modern electromagnetic theory. . . . Manual training is no substitute for intellectual training, although it may supplement it most effectively." This editorial was no doubt written by the late Dr. Louis Bell, editor of the paper at the time. He had just previously taken an active part in the development of the electrical course at Purdue University.

Teachers' Salaries Too Low.

The paper early deplored the low salaries paid to instructors in electrical engineering, stating a third of a century ago: "It would seem as if technical education of an engineering nature, owing to its importance in the industrial world, demanded the employment of the best men obtainable, and if our leading universities expect to obtain these men they must offer them such inducements that positions of this kind will be chosen in preference to commercial work."

As part of its service in the cause of technical education the *Electrical World* in the early nineties published frequent articles on the electrical departments of colleges and universities, at first using wood cuts to illustrate them, and later halftones. An American engineer, F. C. Perkins, was commissioned to write an extensive series of articles on "Technical Education in Europe." These appeared during 1893 and 1894.

Electrical World Backed S. P. E. E.

The paper was greatly interested in the formation of the S. P. E. E., in 1893, in which teachers of electrical subjects were active from the start. Reports of the annual meetings of the Society have been published by it for many years. The editor at the time the Society was formed and, with the exception of four years, for nineteen years thereafter, was the late W. D. Weaver, a graduate of the United States Naval Academy, a widely traveled man and a scholar of broad interests. He printed in the paper each week a department of educational notes, a news service of great value to technical education. At frequent intervals he printed long editorials covering lucidly the fundamentals of the subject.

Three outstanding points which Mr. Weaver, his colleagues and his successors made emphatic in their writings were:

1. The need of high standards and broadly cultural studies in the electrical engineering curriculum.
2. The importance of research in connection with engineering training.
3. The dependence of the success of electrical education upon the qualifications of the teachers employed.

High Standards in Instruction.

Writing, in 1903, on the first subject, the editors said: "So far as the electrical engineer is concerned, the standard can hardly be too exacting. . . . We are glad to point to the attention given to the 'humanities' in the curriculum and to the emphasis laid on mathematics. Quite aside from his technique the electrical engineer should be altogether the equal of practitioners in other professions by his acquaintance with general culture, his acquirement of the qualities and amenities that distinguish the gentleman."

Referring to two serious faults of American technical education, criticised by a foreign visitor, namely the attempt to do too much in a limited time with resulting superficiality, and the excess of manual as compared with mental training,

the *Electrical World* said: "We wish that some of our strenuous and solemn-visaged educators who spell themselves in large capitals and have so little sense of humor as to take themselves seriously would cut out these two quotations [which were given in the article] and paste both into their hats."

On the subject of research the paper, in 1901, was prompted by the great benefaction of $30,000,000 to Stanford University to say that "While we would be slow to say that education is overdone, it does seem as though there were getting to be too many educational establishments, while laboratories are all too few." Or, a few months later, in a discussion of the growth of engineering education, "Just now pure science is in a questioning, tentative state, that state of unrest which precedes momentous advances, and the keener eyes are watching for the results. Practice can care for itself amply well for a while, and it is time to have a care lest we get out of sight of theory and miss the shortest trail."

Two quotations will serve to show what the paper stands for in regard to the teacher: "In teaching, the individual men who carry on the business are of more consequence than the methods they adopt." "A teaching career is worth while only if continued for a number of years with the ultimate hope of rising into the ranks of the leading professors of the country; success in teaching is inseparably connected with a constant study of the fundamentals of the theory of electricity, from different points of view and in various applications."

Space limitations forbid further quotations from educational editorials, but it will suffice to say that the positions taken have been consistent. The intent has been not only to assist students and educators in their efforts, but to suggest to industry ways in which it can coöperate with the schools in adapting graduates to their industrial environment.

Mention should also be made of the *Electrical World's* statistical service in this field. In 1907 it inaugurated an annual canvass of the departments of electrical engineering of the country to secure data not otherwise promptly avail-

able. The resulting compilation at once took its place as part of the annals in this field. The comments of the editors accompanying the publication of the summary are each year significant and valuable.

The Publishers Back of the Paper.

For twenty-five years the owner of, and controlling spirit in the *Electrical World* has been James H. McGraw. This explains in part the continuous support which the paper has given to technical education during this period. Mr. McGraw is before everything else an educator. He intended to be a public-school teacher and to that end completed a normal-school course in 1884. He was thus in the normal school when the erstwhile *Operator* became the *Electrical World.* After a year of public-school teaching he saw a larger field in industrial publishing. In all his publishing activities, however, he puts education first.

Mr. McGraw's predecessor was the late W. J. Johnston, who founded the *Electrical World* and was owner of the *Operator* before it, almost from the beginning. Mr. Johnston was in youth a telegraph operator, but he also had a keen interest in education. No articles published in the paper in his day received more careful attention than did those in this field.

ENGINEERING EDUCATION IN CHINA.

BY THOMSON E. MAO,

Dean of the College of Engineering, National Southeastern University.

This paper purports to give a glimpse of the engineering education in China and is in no way to be considered as a statistical study of its development and growth. On account of the limited amount of time at his disposal the writer will make no attempt at any lengthy discussion of the topics involved.

As in Europe and America the development of engineering education in China is very late. Engineering schools really worthy of the title did not come into existence until the opening of this century. Among those earlier institutions may be mentioned the Peiyang University at Tientsin, founded 1903, Tangshan Engineering College at Tangshan, founded 1906, and the Engineering Departments of the Nanyang University at Shanghai, founded 1906. Since then, in the short span of about twenty years there has been a rapid increase in the number of schools devoted to engineering education, of which the following are representative: Government Technical College at Peking, Engineering Department of the Shensi University at Taiyuan, Hongkong University at Hongkong, Tung Chi University at Woosung, (formerly at Shanghai), Conservancy Engineering College at Nanking, Engineering Department of Nankai University at Tientsin, College of Engineering of National Southeastern University at Nanking, Institut Franco-Chinois d'Industrie et de Commerce at Shanghai, and the Provincial Technical College in Kiangsu, Chekiang and other Provinces. These institutions all aim to maintain high standards in technical education and are to be distinguished from the trade or vocational schools of which there are great numbers scattered all over the country.

Practically all of those institutions are under the control of the Chinese Government, the only exception being the Hongkong University which is operated by the British Government.

From a casual study of the catalogs and bulletins issued by these technical institutions it will be found that the courses of study offered therein are of varied nature. Civil engineering course is by far the most common, as is to be expected in a country whose resources are under exploitation. The courses offered at the different institutions are listed as follows:

Peiyang University	Civil Engineering
	Mining Engineering
	Metallurgical Engineering
Tangshan University	Civil Engineering
Nanyang University	Mechanical Engineering
	Electrical Engineering
Government Technical College	Mechanical Engineering
	Chemical Engineering
	Textile Engineering
Shensi University	Mechanical Engineering
Hongkong University	Civil Engineering
	Mechanical Engineering
	Electrical Engineering
Tung Chi University	Civil Engineering
	Mechanical Engineering
	Electrical Engineering
Conservancy Engineering College	Civil Engineering
Nankai University	Mining Engineering
Southeastern University	Civil Engineering
	Mechanical Engineering
	Electrical Engineering
Institut Franco-Chinois	Civil Engineering
	Mechanical Engineering
	Electrical Engineering
Kiangsu Technical College	Civil Engineering
	Chemical Engineering
	Textile Engineering

The general plan of studies of these different institutions

is by no means uniform. As modern engineering is perfectly new to China the system and methods adopted by the institutions are necessarily foreign in origin. This is largely determined by the members on the faculty, whose education and nationality have much to do in fixing the policy. On account of the large number of American returned students holding responsible positions in the educational world in China, most of the engineering schools adopt American pattern in their curricula, methods of teaching, and laboratory practice. They use American textbooks, American machines and American apparatus. The outstanding exceptions to the above practice are found in the Tung Chi University, Institut Franco-Chinois and the Hongkong University. In Tung Chi University whose teaching staff is composed of almost all German professors, the prevailing is dominant in typically German. For the same reason French influence is dominant in the Institut Franco-Chinois and British influence in the Hongkong University. A remarkable feature about these three institutions is that they are all splendidly equipped with machineries and equipments, Tung Chi University with German make, Institut Franco-Chinois with French make and the Hongkong University with British make. Most of these equipments are donated to the institutions by the industrial enterprises of the respective interested nations. In the other schools where American methods and practice are in vogue, however, the laboratory equipment is generally not so elaborate due to the fact that their machines and apparatus have to be procured at cost.

The number of students enrolled in the different institutions varies with the circumstance. The total number now stands at little over two thousand, an insignificant fraction of the total population. These students upon conclusion of their courses are generally engaged in their respective lines of work, but due to the industries in China being not well developed, not many opportunities are available for them to demonstrate their ability. In spite of this discouraging fact, however, important engineering works in China to-day are mostly handled

by men turned out by these technical institutions. Those who come in touch with these engineering graduates generally concede that they are dependable and excellent in office and field work when following routine instructions. These men have much to accomplish in the age of industrial development which is now arresting China's attention.

The above short and brief account attempts to sum up the whole story of engineering education in China. To an outsider its development and growth have certainly testified the fact that this important branch of education has not been neglected in China. But to scrutinize into the real situation and to get down to rock bottom of facts it is natural that one would find its shortcomings and inefficiencies. As this phenomenon is equally true in Europe and America, undoubtedly in a less degree, China is in a position to profit herself by the strenuous studies made after painful experiences in the West. Generally speaking, the causes that tie down the efficiency of engineering education in China are found both within and without the schools. In the first place the physical equipment is far from being adequate for teaching and experimental purposes; this is especially unfortunate in China where the students having little to see outside must necessarily rely on shops and laboratories for their practical training. On the question of the teaching staff Chinese engineering schools are experiencing the same difficulty as found in Europe or America. To turn out graduates possessing breadth of view and culture requires the service of broad-guage teachers of personality and character. How such men are to be found and, when found, how to make them stay willingly, is indeed a problem still untackled in China. Chinese engineering students are generally criticized as not practical. The only remedy to this curse is to put into operation the coöperative plan of study wherein the students divide their time in alternate shifts between the college and actual work in some industry, as is now in successful operation in several colleges in America. It is unfortunate that industries in China are generally unwilling to work with schools under this plan, inas-

much as they are still in their infancy stage and a successful working of the plan must necessarily involve inconvenience and trouble to the firms concerned. For along time Chinese engineering schools have adopted a partial coöperative plan by sending their graduates to practice in different shops abroad, but the plan is not very successful as the doors to these students are not quite open.

These are but a few of the salient features that characterize ize the inefficiency of engineering education in China. There are, of course, various other reasons contributory to the same result which might be equally fatal if not more.

In this important phase of engineering education, as in many other things, China has much to learn from her friendly nations which have achieved wonderful accomplishments in engineering and science. Advice and counsel coming from such sources are always beneficial and welcome.

MINUTES OF THE THIRTY-SECOND ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

UNIVERSITY OF COLORADO, BOULDER, COLO.,

JUNE 25–28, 1924.

The thirty-second annual meeting of the Society for the Promotion of Engineering Education was held at the University of Colorado, Boulder, Colo., June 25 to 28, 1924. The sessions were held in the Macky Auditorium. There were 367 members and guests registered, representing thirty-eight states, Hawaii and Canada, and seventy institutions. President Perley F. Walker, Dean, School of Engineering, University of Kansas, presided.

There was a meeting of the members of the Society interested in mining education at the Colorado School of Mines, Golden, Colo., on Wednesday afternoon, June 25, with thirty-three registered. President Victor Alderson of the School welcomed them and Director C. H. Fulton of the Missouri School of Mines responded for the Society. The following program was carried out:

Papers.

"The Value of Problems in Teaching Metallurgy:" C. B. Carpenter.

"The Experimental Ore Dressing and Metallurgical Plant of Colorado School of Mines:" S. P. Warren.

"The Teaching of Mining Accounting:" C. R. Forbes.

"The Economic Side of Coal Production in the Field:" C. M. Young.

Discussion.

Inspection of the Colorado School of Mines.

THE THIRTY-SECOND ANNUAL MEETING.

MINUTES OF THE REGULAR SESSIONS.

Thursday, June 26.

The thirty-second annual meeting of the Society was called to order by the President, Dean P. F. Walker, at 9.00 A.M. President Walker invited Director C. H. Fulton, Chairman of the Committee on Metallurgy, to preside at this meeting as it was to be devoted to the subject of mining engineering. In the absence of Dean G. M. Butler, Dean F. A. Thomson read his paper on "The Development of Mining Engineering Education Since 1910." Dean G. B. Pegram addressed the Society on "The Working out of a Six-Year Course at Columbia." Discussion.

The report of the Treasurer, Mr. W. O. Wiley, was read and accepted. The report of the Secretary, Dean F. L. Bishop, was read and accepted. Professor G. C. Shaad, Chairman of the Membership Committee reported 200 new individual and 22 institutional members for the year. This report was accepted and upon motion the committee will continue for another year. Dean H. S. Boardman, Chairman of the Committee on Sections and Branches, reported progress.

The invitation of Union College to hold the 1925 meeting at that institution was accepted by the Society.

President Walker appointed a committee on resolutions consisting of the following: G. C. Anthony, Tufts College, *Chairman*, G. W. Bissell, Michigan, J. L. Newcomb, Virginia, J. R. Macarthur, California, and J. H. Felgar, Oklahoma.

Second Session, Thursday, June 26, 2 P.M.

This meeting was called to order by President Walker who introduced George Norlin, President of the University of Colorado, who welcomed the Society to the University. President Walker responded for the Society. Dean H. S. Evans read a paper on "What is the Meaning of the Bachelor of Science Degree in Engineering?" Professor W. H. Burger read the paper prepared by him and Director John F. Hay-

ford on "Fifteen Years' Experience with a Five-Year Engineering Curriculum." Discussion.

Third Session, Friday, June 27, 10:30 A.M.

President Walker opened this session by announcing that the proposed changes in the Constitution had been referred back to the Committee on the Revision of the Constitution for some minor changes with the exception of the following articles:

The formal publications of the Society shall be a monthly journal to be published from September to June inclusive, and a year book.

The annual dues, including the subscription price of the *Journal*, shall be $4.00 for individual members, and $10.00 for institutional members. Each institutional member will receive two copies of the *Journal* and two copies of the bound volume of the "Proceedings of the Society."

These articles were recommended to the Society by the Council for adoption and upon motion they were adopted.

Dean Carl E. Seashore addressed the Society on "The Student as an Individual." In the absence of Director C. R. Mann, Professor C. J. Tilden described the work of the American Council on Education. Discussion.

Fourth Session, Friday, June 27, 2 P.M.

The afternoon session was opened by President Walker and devoted entirely to the work of the Board of Investigation and Coördination. Mr. W. E. Wickenden, Director of Investigations, described this work in detail.

The Nominating Committee reported the following and by unanimous vote they were elected to serve:

For President, A. A. Potter, Dean of Engineering, Purdue University, Lafayette, Ind.

For Vice Presidents: R. S. King, Professor of Experimental Engineering, Georgia School of Technology, Atlanta, Ga. G. B. Pegram, Dean, School of Mines, Engineering and Chemistry, Columbia University, New York City.

For Secretary: F. L. Bishop, Dean, School of Engineering and School of Mines, University of Pittsburgh, Pittsburgh, Pa.

For Treasurer: W. O. Wiley, Treasurer, John Wiley & Sons, Inc., 440 Fourth Avenue, New York City.

For Members of the Council for three years:

G. M. Butler, Dean, College of Mines and Engineering, University of Arizona, Tucson, Ariz.

Harold Pender, Dean, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa.

W. E. Wickenden, Director of Investigations, Society for the Promotion of Engineering Education, Room 1607, 33 West 39th Street, New York City.

Earl B. Norris, Dean of Engineering, University of Montana, Bozeman, Mont.

W. E. Brooke, Head, Department of Mathematics and Mechanics, College of Engineering, University of Minnesota, Minneapolis, Minn.

W. H. Kenerson, Chairman, Division of Engineering, Brown University, Providence, R. I.

H. H. Jordan, Assistant Dean, College of Engineering, University of Illinois, Urbana, Ill.

Fifth Session, Saturday, June 28, 1924, 9:30 A.M.

This final meeting was called to order by President Walker at 9.30 A.M. President F. W. McNair presented the following resolutions which had been approved by the Council and recommended to the Society for adoption. Upon motion these were formally adopted:

"WHEREAS, The Carnegie Corporation has granted a generous sum of money to be expended under the direction of this Society for the improvement of engineering education, therefore at this, the annual meeting of the Society next succeeding this grant, be it

Resolved: That the Society for the Promotion of Engineering Education expresses its profound appreciation and grati-

tude for the support of the Carnegie Corporation in this important educational enterprise."

Charles C. Gates, President of the Gates Rubber Company of Denver, addressed the Society on "Industrial Development of the West." Professor C. L. White read his paper on "The Freshmen." Professor T. P. Harrison presented a paper on "An Experiment in Teaching Freshmen in Engineering How to Study." Discussion.

Professor J. Raleigh Nelson, Chairman of the Committee on English, reported for that Committee. Secretary Bishop read the report of the Committee on Drawing. The Committee on Resolutions made the following report which was unanimously accepted by a rising vote:

Your Committee on Resolutions find themselves greatly embarassed in their attempt to adequately express the deep sense of gratitude and appreciation felt by the members for the innumerable courtesies extended by the University of Colorado, its associate committees and the City of Boulder, all of which have been extended to us with such a fine sense of hospitality. The real spirit of our appreciation can be read only between the lines. Therefore, be it

Resolved: That the appreciation and thanks of the Society for the Promotion of Engineering Education be expressed to the President and to the Regents of the University of Colorado, and to the Dean and Faculty of the College of Engineering for their cordial welcome, hospitality and coöperative efforts in making this Boulder meeting one of such success and a lasting and greatly cherished memory;

To President and Mrs. Norlin for the hospitality extended us in the delightful reception at their home;

To the Local Committee for its perfectly planned and successfully executed provision for our comfort and happiness at this meeting; for their wisdom in the choice of excursions and entertainments, together with their tireless efforts in securing for us constant service, ease and perfect safety in transportation;

To the Local Committee of Ladies for their hospitality to and thoughtful consideration of the ladies of the convention and the delightful entertainment afforded them;

To the Committee of Boys and Girls who have contributed such pleasure to the younger visiting members, and to the

very new and greatly appreciated Committee for the care of our infant membership;

To Dr. F. W. Chace for the pleasure and inspiration derived from his most enjoyable organ recital;

To Mr. E. G. Fine for the scholarly lecture and the artistic illustrations of this most beautiful State of Colorado;

To the Country Club of Boulder for the privileges afforded us in the use of their grounds;

To the Public Service Company of Colorado for the courtesies extended to us at their Lakeside Power Plant;

To the Colorado School of Mines at Golden for its cordial welcome and

To the City of Boulder for its thoughtful consideration and courtesies extended to the Society through its Chamber of Commerce.

The convention adjourned at 12:45 sine die.

MINUTES OF THE MEETINGS OF THE COUNCIL, UNIVERSITY OF COLORADO, BOULDER, JUNE 25, 26, 27, 28, 1924.

Members present: D. S. Anderson, G. C. Anthony, E. J. Babcock, Edw. Bennett, F. L. Bishop, H. S. Boardman, G. R. Chatburn, H. S. Evans, O. J. Ferguson, F. A. Fish, A. M. Greene, Jr., D. C. Jackson, H. S. Jacoby, O. M. Leland, F. W. McNair, W. T. Magruder, Anson Marston, G. C. Shaad, A. N. Talbot, F. E. Turneaure, P. F. Walker, and W. O. Wiley.

The following actions were taken:

1: The report of the Secretary was accepted and will be published in the journal of ENGINEERING EDUCATION.

2. The report of the Treasurer was accepted and will be published in the journal of ENGINEERING EDUCATION.

3. The invitation of Union College to hold the 1925 meeting at that institution was accepted.

4. After discussing the length of the annual meetings, it was voted that the convention in 1925 would start officially on Wednesday night and end on Saturday noon. It was the sense of the Council that a meeting for mechanical engineers be held at Troy on Wednesday before the commencement of the annual meeting. Conferences for those committees who desire them, will also be arranged.

5. The American Association for the Advancement of Science asked to have the question of withdrawing from membership reopened and if possible that this Society retain its official connection. The Council voted to reaffirm the action of last year to withdraw.

6. The application of the "United Y. M. C. A. Schools" for institutional membership was not accepted and they were notified that it is impossible to accept for institutional membership an association of schools and that should individual schools wish to apply, the applications would be considered by the Council.

7. C. J. Tilden, Yale University, was reappointed a member of the Committee to represent this Society in the American Council on Education.

8. It was voted that it is the sense of the Council that this Society does not consider a code of professional practice.

9. This Society approves a code of ethics such as those prepared by the National Engineering Societies; that we are willing to assist but not to direct.

10. The question of grading electrical and mechanical schools such as the Medical Association grading of medical schools, was referred to the Board of Investigation and Coördination.

11. President A. A. Potter was appointed to represent this Society on the Coffin Foundation.

12. The Council recommended to the Society for adoption the following resolutions:

WHEREAS, The Carnegie Corporation has granted a generous sum of money to be expended under the direction of this Society for the improvement of engineering education, therefore at this, the annual meeting of the Society next succeeding this grant, be it

Resolved: That the Society for the Promotion of Engineering Education expresses its profound appreciation and gratitude for the support of the Carnegie Corporation in this important educational enterprise.

13. The Council recommended that the presidents of institutional members be requested that, where it is possible, that only members of the Society be sent to the annual meetings, and meetings of the Division of Deans and Administrative Officers, as representatives.

14. That persons who are elected to membership do not become members until they pay their dues and that no copies of the journal of ENGINEERING EDUCATION be sent to them until the dues are paid.

15. The Council recommended to the Society the following revised articles of the Constitution for adoption:

The formal publications of the Society shall be a monthly

journal to be published from September to June inclusive, and a year book.

The annual dues, including the subscription price of the journal, shall be $4.00 for individual members, and $10.00 for institutional members. Each institutional member will receive two copies of the journal and two copies of the bound volume of the Proceedings of the Society.

16. That the Secretary of the Society be a member of the Board, *ex officio*, instead of Secretary of the Board, *ex officio*.

17. That recommendation 3 of the Report of the Development Committee of August 8, 1922, regarding the Director of Investigations which reads "and when appointed to be *ex officio* chairman of the Board" be cancelled.

18. That Dean M. E. Cooley be reappointed a member of the Board of Investigation and Coördination for five years.

19. The following budget was approved for 1924–25:

Receipts:		
Individual dues		$ 6,000.00
Institutional dues		1,060.00
Back dues		500.00
Advertising		2,000.00
Sale of publications		1,000.00
Total estimated receipts		$10,560.00
Disbursements:		
A. 1924 Boulder meeting	$ 400.00	
C. Journal of the Society	4,600.00	
D. Committee expenses	150.00	
F. Secretary's honorarium	1,000.00	
H. Clerical assistance	2,000.00	
I. Sundry printing	300.00	
J. Postage and expressage	200.00	
K. Telephone and telegraph	50.00	
L. Office supplies	50.00	
		8,750.00
Estimated surplus		$ 1,810.00

17. The following applicants were recommended to the Society for election:

Allen, David Robert, Professor of Mathematics, University of Utah, Salt Lake City.

Ball, Max W., President, Marine Oil Company, First National Bank Building, Denver, Colo.; President of Trustees, Colorado School of Mines, Golden, Colo.

Berger, Franz Alfred, Associate Professor of Mechanical Engineering, Washington University, St. Louis, Mo.

Blackadder, William, Professor of Engineering, The University of Aberdeen, Aberdeen, Scotland.

Boase, A. J., Professor of Civil Engineering, Pennsylvania Military College, Chester, Pa.

Brigham, Leslie E., Assistant Professor of Hydraulics and Irrigation Engineering, Oregon State Agricultural College, Corvallis, Ore.

Collier, Ira Leonard, Assistant Professor of Civil Engineering, Washington University, Seattle, Wash.

Crenshaw, John Bascom, Professor of Modern Languages, Georgia School of Technology, Atlanta, Ga.

Cross, Frank C., Professor of English and Economics, Colorado School of Mines, Golden, Colo.

Dahlene, Oscar, Professor of Engineering and Mathematics, University of Alabama, Tuscaloosa, Ala.

Dunn, Theodore S., Professor of Geology and Metallurgy, Georgia School of Technology, Atlanta, Ga.

Eastom, Frank Amos, Instructor in Electrical Engineering, University of Colorado, Boulder, Colo.

Faunce, Wayne Moody, Instructor in Engineering, Brown University, Providence, R. I.

Feusse, Elmer George, Professor of Chemistry, Southeastern Louisiana Institute, Lafayette, La.

Green, Boynton M., Instructor in Mechanical Engineering, Stanford University, Stanford University, Calif.

Hall, Howard Judson, Associate Professor of English, Stanford University, Stanford University, Calif.

Hamilton, James Baker, Instructor, University of Washington, Seattle.

Howitt, Nathan, Instructor in Electrical Engineering, Harvard University, Cambridge, Mass.

Hughes, George Griffin, Professor of Engineering, Southeastern Louisiana Institute, Lafayette, La.

Hunley, William M., Professor of Economics, Virginia Military Institute, Lexington, Va.

Kinney, Harvey Smith, Instructor in Electrical Engineering, University of Nebraska, Lincoln, Nebr.

Koenig, Lloyd Roesch, Instructor in Mechanical Engineering, Washington University, St. Louis, Mo.

McKenry, Nell, Assistant to the Secretary, Society for the Promotion of Engineering Education, University of Pittsburgh, Pittsburgh, Pa.

Manning, William Albert, Professor of Applied Mathematics, Stanford University, Stanford University, Calif.

Mock, Frank Charles, Instructor in Electrical Engineering, University of Illinois, Urbana, Ill.

Nichols, Charles Sabin, Professor of Sanitary and Hydraulic Engineering, Iowa State College, Ames, Iowa.

Rees, Robert I., Assistant Vice-President, American Telephone and Telegraph Company, 195 Broadway, New York City.

Stokes, William Bee, Professor of Mathematics, Southwestern Louisiana Institute, Lafayette, La.

Sussdorff, Edmund L., Assistant Professor of Mechanical Engineering, University of Vermont, Burlington, Vt.

Taylor, Albert LeRoy, Associate Professor of Mechanical Engineering, University of Utah, Salt Lake City, Utah.

Thomas, Earl Charles, Assistant Professor of Civil Engineering, Stanford University, Stanford University, Calif.

Thompson, Henry Clay, Jr., Instructor in General Engineering, University of Colorado, Boulder, Colo.

Tyrell, Henry Grattan, Consulting Engineer and Engineering Author, 828 North Carrollton Avenue, Baltimore, Md.

Warner, Russell G., Assistant Professor of Electrical Engineering, Yale University, New Haven, Conn.

West, Ray Benedict, Dean of Agricultural Engineering and Mechanic Arts, Utah Agricultural College, Logan, Utah.

Wheeler, William Henry, Instructor in Civil Engineering, Washington University, St. Louis, Mo.

Wiepking, Christopher Armin, Instructor in Mechanics, University of Wisconsin, Madison, Wis.

Wooten, Louis Ernest, Assistant Professor of Civil Engineering, North Carolina State College, Raleigh, N. C.

Woodson, Ashby, Professor of Mechanic Arts and Drawing, Southwestern Louisiana Institute, Lafayette, La.

Louisiana Polytechnic Institute, Ruston, La., J. E. Keeny, President.

39 individual members and 1 institutional member = 40.

Respectfully submitted,

F. L. BISHOP,
Secretary.

ITEMS OF INTEREST.

Mr. H. P. Hammond, Professor of Sanitary and Hydraulic Engineering, Polytechnic Institute of Brooklyn, has been appointed Associate Director of Investigations. Mr. Hammond assumed his duties on June 15, 1924.

Mr. W. E. Wickenden, Director of Investigations, will spend the latter part of the year 1924–25 in Europe studying engineering education.

By action of the Council, subscriptions to the journal of ENGINEERING EDUCATION will begin upon receipt of dues. New members, therefore, will not receive copies until they have paid the first year's dues.

This action will apply also to members in arrears. Their subscriptions will be discontinued until the arrearage is paid.

President A. A. Potter will represent the Society on the Charles A. Coffin Foundation.

Dean F. L. Bishop will represent the Society at the Centennial Celebration of the Rensselaer Polytechnic Institute on October 3 and 4, 1924.

Professor C. J. Tilden was reappointed a member of the Committee to represent this Society on the American Council on Education. The other members are Hugh Miller and F. L. Bishop.

Professor G. C. Shaad has been reappointed Chairman of the Membership Committee.

The 1925 meeting of this Society will be held at Union College, Schenectady, N. Y., in June. The exact dates have not yet been determined.

Dean M. E. Cooley has been reëlected a member of the Board of Investigation and Coördination for a period of five years, his term having expired this year.

Dean H. S. Boardman was elected Chairman of the Division of Deans and Administrative Officers. Dean G. C. An-

thony and Dean H. S. Evans were appointed a Committee on Program and are to confer with the Chairman.

The Committee on English held one joint conference with the Division of Deans and Administrative Officers. There were two other conferences held during the meeting by this Committee. Professor J. Raleigh Nelson, Chairman of the Committee on English presided.

The Institutional delegates held a meeting on Saturday, June 28, at which Dean O. J. Ferguson, Vice-President of the Society presided.

President P. F. Walker gave his Presidential Address, "The Engineer in Public Service," at the annual dinner at the Boulderado Hotel on Friday evening, June 27.

The Council of the Society met the first day of the convention at 6:00 P.M. and every day thereafter (3) at breakfast at 7:30 A.M. The average attendance at these meetings was twenty.

The Board of Investigation and Coördination held two meetings, one on Friday, June 27, at noon, and the other on Saturday, June 28, at noon. Professor Charles F. Scott, Chairman of the Board, presided.

SECTIONS AND BRANCHES.

Case School of Applied Science. The third meeting of the 1923–24 year was held on Monday, May, 5, 1924. Professor Thompson presided and fifteen members were present.

The following members were unanimously elected as officers of the branch for the college year 1924–25:

President—C. L. EDDY.

Sec.-Treasurer—W. E. NUDD.

Programme Committee—A. JENKIN, C. F. THOMAS AND C. L. PRUTTON.

Professor Thompson gave a resume of the meeting of the Ohio Section of the S. P. E. E. which was held at Columbus, Ohio, on Saturday, April 26, 1924. A spirited discussion followed.

ANTHONY JENKIN, *Sec.*

The spring meeting of the **University of Kansas Branch** of the Kansas-Nebraska Section of S. P. E. E. was held at the University of Kansas, May 8, 1924.

In the afternoon session President P. F. Walker outlined the general plan of the meetings to be held at Boulder next summer and the plans he had made for forming a caravan of the members of the Kansas-Nebraska section who were traveling by automobile to Boulder.

The discussion for the afternoon was led by Professor A. M. Ockerblad on the subject of "Consolidation of the Engineering Courses in the First Two Years." Other members who took part in this discussion were Professors C. H. Ashton of the Mathematics department, H. P. Cady, of the Chemistry department, M. E. Rice, of the Physics department, Esther Wilson of the English department, and Dean P. F. Walker.

At 6:30 o'clock dinner was served at the Country Club.

At the evening meeting the subject for discussion was "Results Obtained From the Fundamentals Course for Freshmen

Engineers." The leader was Professor F. E. Johnson of the Electrical Engineering department. Other members who participated in this discussion were Professors Warren R. Neuman, F. A. Russel, Frank L. Brown, John A. Dent, F. B. Dains, A. H. Sluss, P. F. Walker, and R. L. Grider.

President J. L. Howe and Mr. Traxler of Highland College, Highland, Kansas were guests at the meetings.

A. H. SLUSS, *Secretary pro tem.*

The **Minnesota Section** of the Society for the Promotion of Engineering Education held its meeting of the year in the Ball Room of the Men's Union at 5:45 o'clock, Wednesday, May 28, 1924. Twenty-five members and guests were present.

Professor Brooke, Chairman of the Nominating Committee, reported the names of the following men: for President, Professor Frederick Bass; for Secretary, Professor R. W. French, for Chairman of the Program Committee, Mr. E. W. Johnson. The nominees were unaminously elected.

The paper of the evening was given by Professor J. H Forsythe, Chairman of the Students' Work Committee in the College of Engineering and Architecture, on "The Relationship of the Students' Work Committee to Scholarship Standards." This illuminating paper was followed by a very interesting discussion.

H. B. WILCOX, *Secretary.*

Purdue Branch. The spring meeting of the Purdue Branch of the Society for the Promotion of Engineering Education was held May 16 in the lecture room of the "Michael Golden Shops," the invitation of Professor J. D. Hoffman, Head of the Department of Practical Mechanics, to devote an evening to the consideration of the educational value in shop training having been accepted. This proved to be the most important and interesting meeting of the entire school year.

The meeting opened at 7:00 P.M. with chairman S. D. Chambers presiding. After a few explanatory remarks Professor Chambers turned the meeting over to Professor Hoff-

man, Head of the Department of Practical Mechanics, who explained some of the educational values in shop work and then introduced Professor W. P. Turner, Professor of Practical Mechanics, the principal speaker of the evening.

Professor Turner who had provided an exhibit of the products made in the machine shop, emphasized the fact that though the shop man could operate a well-designed machine, it is the problem of the student to thoroughly understand the layout of the work, as well as the setting up and operation of the different machines.

He always has before him the problems involved in the flow of metals under pressure as in drop forging, the changing characteristics of metals under heat treatment and tempering, with daily experience in his exercises. This work opens up the vast field of molecular physics to those men capable of profiting by that work.

Methods of quantity production are illustrated by the use of a series of punch press and drop forging dies designed and made in the shops. These together with automatic screw machine worked provide such necessary parts as are needed in the Purdue Gas Engine. As Professor Turner says, "The machine shop produces a product and a by-product; the student is the product while the machined parts are the by-product."

After the formal session was over an inspection trip through the forge and machine shops was taken. Illustrations of hand punches being correctly and incorrectly tempered, spot welding by electricity, die punching and the manufacture of parts for the Purdue two cycle marine gas engine were shown. Later the engine was exhibited running, the power being absorbed by a friction brake. All through the shops emphasis was laid on the " Safety First " devices installed to protect the student. One of the most interesting of all the exhibits was the method of measuring the deflection of a steel bar 5 inches in diameter and approximately 3 feet long by wavelength of monochromatic light (Selenium). So sensitive was the apparatus that the compression could be measured when

the fingers were placed at each end either above or below the neutral axis. The weight of the hand in the center of the bar produced a measurable deflection as did also the warmth of the hand without weight. The meeting adjourned at 9:00 P.M.

JOHN A. NEEDY, *Secretary.*

RENSSELAER POLYTECHNIC INSTITUTE AND THE EARLY COLLEGES OF ENGINEERING.

BY RAY PALMER BAKER,

Professor of English in Rensselar Polytechnic Institute.

During the first week of October, Rensselaer Polytechnic Institute celebrates the hundredth anniversary of its foundation. For many reasons this fact is of general interest. The school founded at Troy in 1824 by Stephen Van Rensselaer was the first to provide a training in agriculture, it was the first to develop an undergraduate routine based upon the interrelation of the natural and social sciences; and it was the first to offer graduate instruction, drawing students from nearly a hundred centres of higher learning. In this sketch, however, I do not intend to deal with these aspects of its history, significant as they are, but with its development as a college of engineering and its influence upon the institutions which followed in its wake.

Revolutionary as was its influence, there was nothing revolutionary about its origin. In half a dozen colleges instruction in the sciences had been offered before 1800. In others, provision of an elementary character had been made before 1820. Moreover, as President Ricketts has explained in the second edition of his admirably comprehensive "History of Rensselaer Polytechnic Institute,"* the Gardiner Lyceum, which survived for a decade, was opened in 1823. By 1824, therefore, many educators evidently realized that a change in policy was imperative. In fact, recognition of the need seems to have been fairly general. At Cambridge, Joseph Story, chairman of a special committee appointed at the instance of George Tichnor, presented a report advocating the establishment of a department in which students would be

* New York, 1895, 1914.

permitted " to pursue particular studies to qualify them for scientific and mechanic employment and the active business of life." When a group of citizens met at White's Hotel, in Easton, to discuss the organization of a college, they voted to include in the curriculum not only the " dead languages . . . usually taught " but also " civil and miltary engineering." Neither Harvard nor Lafayette, however, was able to carry out its plans until, a generation later, it was able to draw upon the graduates of the Institute who had been trained in the disciplines which these gentlemen had advocated. Though their proposals led to no immediate results, the current opinion that Rensselaer sprang meteor-like from pedagogical chaos does not appear to be justified by the facts. Like every striking development, it was the climax in a process of evolution. It was unique only in finding a benefactor and a leader.

The first of these two men was Stephen Van Rensselaer, Patroon of Rensselaerwick. As he owned nearly a thousand farms, he had always taken a personal interest in the progress of agriculture. Consequently, when he established a school for the " sons and daughters of farmers and mechanics," he defined its aim as the application of science to " agriculture, domestic economy, the arts and manufactures." With him, therefore, agriculture was supreme. On the other hand, although Amos Eaton, senior professor, and one of the great figures in the history of American education, did not forget his aspirations in this field, he gradually stressed the importance of industry. Even in the early days, when the Institute was the chief centre of research in America, and when its students were laying the foundations for their epoch-making achievements in botany, zoölogy, physics, chemistry, geology, and mineralogy, the curriculum leading to the only undergraduate degree—that of bachelor of arts—included the elements of civil, mechanical, and electrical engineering. In 1825 surveying and the elements of hydrostatics and dynamics were listed among the subjects taught. A year

later "general engineering" appeared and, in 1828, "civil engineering." In 1835, when the degree of civil engineer was introduced, four young men presented themselves for examination. They were the first in any English-speaking country to receive a degree in engineering. In ten years, therefore, Eaton, who, in 1835, assumed the title of "professor of civil engineering," developed a closely integrated course in technology which was distinctly professional in character. It is no exaggeration to refer to him as the father of American engineering.

From one point of view, however, Benjamin Franklin Greene ('42), who, in 1847, became director, deserves this honor. As Eaton had insisted that Rensselaer should limit its field to the sciences, and had later drawn a line between the pure and applied sciences, providing sharply differentiated courses for students interested primarily in research or industry, so Greene insisted that it was again time to narrow its field. While pointing out that a school of forestry and a school of agriculture might well be considered, he eliminated them because "as a matter of expediency" they would probably have to be administered independently. While suggesting, also, that a school of commerce "with elevated aims" ought to be included in a polytechnic organization, he nevertheless restricted his recommendations to "matters immediately cognate to architecture and engineering." Because of its historic significance, his treatment of these "matters" is worthy of note.

Greene's point of view was remarkably catholic. Although he emphasized those "matters" which seemed "immediately cognate" to his purpose, he did not overlook those which are more remote but no less essential. In the "general school," as he styled it, which dealt with such subjects as languages—English, French, and German—philosophy, botany, zoölogy, geology, mineralogy, physics, chemistry, mathematics, and the geodetic, graphic, plastic and gymnastic "arts," his aim was to offer a "system of gen-

eral *disciplinary culture*—scientific, literary, philosophic, artistic—prior to entrance upon a study of any form of applied science or art." In the "technical schools," leading to professional preparation, courses were grouped under "general studies" and "special studies," according as they were common to the needs of all groups of students or were applicable to those of one group only. Within the boundaries of the time limit—three years—which he had set, Greene attempted, therefore, to provide a complete liberal and professional education.

In his report, written practically twenty years before Huxley's famous essay, he emphasized the cultural value of the disciplines which he advocated. While expressing his appreciation of the ideals which had illuminated the universities of Europe and his readiness to accept in their own place those which had been borrowed by the colleges of America, he nevertheless insisted on the validity of his own point of view. Not the least of the misconceptions regarding the purpose of the Institute, according to him, was the prevalent idea that its object was distinctly vocational and that it was unable to provide its students "with that completeness of scholarly culture which is comprehended in the idea of a liberal education." Actually, however, he added, its courses were neither "partial" nor "one-sided" but "*adapted to the complete realization of true educational culture*" ministering to all the "powers of perception, of thought, of feeling, of expression, of action" and aiding the undergraduate to meet "the demands and circumstances of the age in which he lives." Such was the wise and tolerant definition with which Greene began his plan of reorganization.

Though it was subject to attack from those who misunderstood his attitude towards the classics, which he expressly recognized, it was also subject to attack by those who would sink "all learning to the level of the merest empiricism." Regarding their onslaught he remarked:

The question may be raised as to the utility of such studies as rhetoric, philosophy, etc., to the architect, engineer, and other technists. It is a natural question, and one not unfrequently asked in these days when the element of *time* which is spent in connection with education is estimated at so high a value. Experience has shown conclusively enough to all observers that in a course so largely—in its very necessities—material as that which obtains in a polytechnic institution there should be introduced compensating or balancing elements. And what studies so suitable as those which cause us to turn from the observation of *things* without to the contemplation of the wonderful phenomena and resources within the human mind? Apart from all consideration of the practical advantages which accrue even to the technist—and they are not only manifold in fact but *ought to be obviously so* to all intelligent and discriminating observers—from this class of studies, we repeat that viewed as a mere *equipoise* to the study of the mathematical, physical, and technical sciences, we believe they should find a prominent place in the educational system of every polytechnic institution.

As I have explained, Greene had envisaged an institution which would deal with all "matters immediately cognate to architecture and engineering." Within the limits of these terms, he included not only "schools" of "civil architecture," "civil engineering" and "mining engineering" but also "schools" of "pure art" and "ornamental art." Because of lack of funds, however, only the "school of civil engineering" offering the degree of civil engineer and topographical engineer was actually organized during his directorship. Though he was unable to introduce many of his recommendations, he charted the trail which others have followed not only at Rensselaer but elsewhere in the United States. With the exception of local divergencies in content and method, engineering education today may be interpreted almost entirely in terms of his report. So sound were his conclusions that Dr. C. R. Mann's study for the Carnegie Foundation consists of little more than a reinforcement of his views as modified by conditions at the time when it was made.

In the leadership of both Eaton and Greene, therefore, Rensselaer was peculiarly fortunate. After their administrations, it found others to further their ideals. In due time, a course leading to a degree in mining engineering was established. In 1862, when the "special class" leading to the curriculum of three years in civil engineering became the first year of the new four-year course, which has remained the norm in the United States and Canada, a curriculum in mechanical engineering was added. By the end of the Civil War, therefore, the essential features of every technical school had appeared at the Institute. It is interesting to note how, through its graduates, they were carried into the younger institutions of the Republic, in which approximately one hundred attained to professorial positions. Influential as such a number would be under any circumstances, they were especially influential because in many cases they established the departments in which they served. In the state universities, in the endowed institutions of the East, and in the technical schools they were a compelling force. A mere list of their names would be almost an index to the history of engineering in the United States.

Since the first class in civil engineering was not graduated from the Institute until 1835; since Amos Eaton, who held the first chair of its kind in any English-speaking country, did not become professor until that time, and since the process of differentiation with which everyone is familiar did not begin until near the end of the nineteenth century, this history is still recent. The achievements of the alumni in the field of education therefore lead directly in many instances to the careers of men now living. In spite of this fortunate obstacle, it is not difficult to indicate the nature of their leadership in the development of the practical arts in the three types of institutions mentioned in the last paragraph.

Their influence has been especially obvious in the state universities. In Michigan, it may be interesting to know, the departments of botany, zoölogy, geology, mineralogy, chem-

istry, and medicine were established by graduates of the Institute. They were responsible, moreover, for instruction in pharmacy, the theory and practice of medicine, and obstetrics and diseases of women and children as well as for the conduct of the library. In 1859, also, De Volson Wood ('57), professor of civil engineering, who served as professor of physics, and who, with President Tappan, had been directed by the Board of Regents to formulate a policy to govern the teaching of the sciences, organized a separate department of engineering from which the first students were graduated in 1861. Among the records of the Board is a minute requesting him to draft a plate for the diploma. In Wisconsin, Ezra Slocum Carr ('38) and James Hall ('32) had been associated in the development of "natural history." In engineering they were seconded by another alumnus of the Institute. Their work as pioneers was paralleled, in Minnesota, by that of Arthur Beardsley ('67), who, in 1870, became professor of civil engineering and industrial mechanics. As such, he instituted the technical departments of the university, outlining the courses from which the present curricula have gradually emerged. Elsewhere the tale is similar. In such universities as Arizona, Missouri, Texas, and West Virginia, in the United States, and Manitoba and New Brunswick, in Canada, and in colleges of agriculture, mechanics, and mining like Iowa, Louisiana, and Colorado, the alumni have been professors and deans, often responsible for the details of organization and administration.

In the colleges and universities of the East, they have been no less active. In Lafayette, Lehigh, Swarthmore, and Trinity, among the smaller colleges, they have been professors of civil, mechanical, and mining engineering. In Lafayette, Joseph Fox ('61), first professor of civil and topographical engineering, laid the foundations of its courses in the applied sciences. Among the other graduates of the Institute who served it at an early period was Justus Mitchell Silliman ('70), Markle Professor of Mining Engineering. At Swarth-

more, which may well be cited in illustration of the formative character of the work done by the graduates of the Institute, Beardsley, leaving Wisconsin, became professor of applied mechanics, professor of mechanics and engineering, and, in 1885, in keeping with developments elsewhere, professor of civil and mechanical engineering. The first incumbent of the Williamson Professorship of Engineering, he established and directed the departments of the college dealing with the practical arts. His career is typical of that of the alumni who have entered the endowed universities. In the West, they organized departments in several institutions. In the East, at Columbia, Cornell, Harvard, New York, Pennsylvania, and Princeton, they have held professorships in engineering. Like most of the colleges founded under the Morrill Act, Cornell drew on Rensselaer not only in geology but also in engineering. In 1873 Estévan Antonio Fuertes ('61), who had already served as engineer-in-chief of the government expeditions to Tehuantepec and Nicaragua to determine the practicability of a ship canal at the Isthmus, was elected dean of the school of engineering. Afterward professor of civil engineering and director of the college of civil engineering as well as professor of astronomy and constructor of the Barnes Observatory, he introduced in Ithaca many of the methods of instruction originated in Troy. To him the university is largely indebted for its excellent laboratories. At Harvard, Eben Norton Horsford ('38), Rumford Professor of the Application of Science to the Useful Arts, who induced Abbott Lawrence to found a school devoted to theoretical and practical chemistry, might also be considered its first professor of engineering, anticipating, therefore, the distinguished alumnus who occupied a professorship later in the century. A somewhat similar relationship existed between James Curtis Booth ('31), professor of chemistry applied to the arts in the University of Pennsylvania, and Edgar Marburg ('85), for nearly thirty years professor of civil engineering and head of the department. During this period the latter ex-

tended the curriculum and, with Professor Spangler, directed the construction of the admirably equipped building now occupied by the Towne Scientific School, in which his name is perpetuated by the Edgar Marburg Memorial Scholarship. Though services as great as his have been rendered by other men—in Princeton, for instance, where the first professor of civil engineering in the John C. Green School of Science was a graduate of the Institute—the character of their labors in the endowed universities ought, by this time, to be sufficiently clear.

On the technical schools, of course, the Institute has reacted even more powerfully. In this case, however, it does not seem necessary to refer to individual professors such as Samuel Edward Warren ('51), of Massachusetts, or De Volson Wood ('57), of Stevens, both of whom were pathfinders in their respective fields. The example set by Rensselaer has been such a potent force in shaping the curricula of other institutions of the same character that the achievements of even the most eminent teachers are easily overshadowed by it. Even a glance at the first courses offered by the Massachusetts Institute of Technology, founded in 1865, shows that, with a few exceptions, they were practically identical with those required at Rensselaer in the same year. In fact, the only striking difference is the larger place given at the Institute to botany, zoölogy, geology, and mineralogy. Since this parallelism occurs in connection with most institutions established after the Civil War, there appears to be no reason to qualify Dr. Mann's conclusions that Greene's report must be ranked with the Industrial Revolution as one of the two stimuli that have directed the destinies of engineering education in the United States.

The influence of the Institute, however, has not been limited to professorships and curricula. Though it gave to Lafayette in the early days several teachers who shaped its courses in the applied sciences, two of its sons, Ario Pardee, Jr. ('58), and Calvin Pardee ('60), both of whose names will

be commemorated by the dormitory now being erected at Rensselaer, were among its greatest benefactors. Indeed, in all matters pertaining to the advancement of engineering as a profession, the alumni have taken a lively interest. Wood, for example, served as first president of the Society for the Promotion of Engineering Education. Richard Pennefeather Rothwell ('58) organized the American Institute of Mining Engineers. In 1892, also, there were in the American Society of Civil Engineers—the chief technical association of the continent—four times as many graduates as from any other institution and as many as from any five other schools or colleges combined. Of fourteen members who today have been connected with the organization for half a century or more, five are alumni of the Institute. Through such professional contacts alone, its indirect influence upon the development of engineering education has been enormous.

Nor has its influence been restricted to the United States. In Japan it has given two professors of civil engineering to the Imperial University at Tokio; in China, it has provided a director for the department in the Imperial University at Tientsin; and among its graduates—nearly two hundred—from the countries of Latin America, a number have devoted themselves to the problems of education. A few like Fuertes, of Cornell, have remained in the North; but most of them have returned to their homes to duplicate there the foundations laid in Troy a century ago by Amos Eaton and Stephen Van Rensselaer.

CENTENNIAL CELEBRATION—RENSSELAER POLYTECHNIC INSTITUTE.

(The oldest college of science and engineering in any English-speaking country.)

TROY, NEW YORK.

October 3 to October 4.

Official delegates from educational institutions, scientific organizations, and engineering societies throughout the world as well as from each alumni association and from each class since 1857.

OCTOBER 3.

Morning.

Academic Procession.

Convocation. Addresses by

Herbert Hoover, Secretary of Commerce of the United States,

Frank Pierrepont Graves, President of the University of the State of New York,

Harry Esmond Clinton, Mayor of Troy,

Sir Charles Langbridge Morgan, President of the Institute of Civil Engineers of Great Britain,

Henri Abraham, President of the Society of Electrical Engineers of France,

Luigi Luiggi, President of the Society of Civil Engineers of Italy,

Arthur Surveyor, President of the Engineering Institute of Canada.

Palmer Chamberlaine Ricketts, President of Rensselaer Polytechnic Institute.

RENSSELAER POLYTECHNIC INSTITUTE.

Afternoon.

Unveiling of Tablets.

1. On the site of the old Main Building, destroyed by fire in 1904. Addresses by Seymour van Santvoord, of Troy, and Mrs. Elizabeth van Rensselaer Frazer, of Washington, a lineal descendant of Stephen Van Rensselaer, founder of the Institute.
2. In the Carnegie Building in memory of S. Wells Williams ('32), first professor of Chinese and Oriental Literature in Yale University. Address by Mr. Sao-Ke Alfred Sze, Envoy Extraordinary and Minister Plenipotentiary from China to the United States.

Inspection of Laboratories.

Evening.

Dinner in the State Armory. Addresses by President Livingston Farrand, of Cornell University, Director Joseph Henry Odell, of the Service Citizens of Delaware, and Huger Wilkinson Jervey, Dean of the Law School in Columbia University.

Pageant on the Campus illustrating scenes in the history of science and engineering during the last hundred years. Written and directed by Thomas Wood Stevens, Head of the Drama Department in the Chicago Art Institute.

OCTOBER 4.

Morning.

Convocation. Addresses by

James Rowland Angell, President of Yale University,

Edward Ashahel Birge, President of the University of Wisconsin,

Samuel Wesley Stratton, President of the Massachusetts Institute of Technology,

Albert Abraham Michelson, President of the National Acad of Sciences,

Carl Ewald Grunsky, President of the American Society of Civil Engineers,

Frederic Rollins Low, President of the American Society of Mechanical Engineers,

William Kelly, President of the American Institute of Mining and Metallurgical Engineers,

Farley Osgood, President of the American Institute of Electrical Engineers.

Afternoon.

Reception by President Ricketts and Mrs. Ricketts.

Evening.

Alumni Smoker.

Pageant.

President Potter has appointed the Secretary, Dean F. L. Bishop, to represent the Society at this centennial celebration.

NECROLOGY.

It is with regret that we announce the death by accident of President F. W. McNair, Mr. John H. Dunlap, and Professor F. W. Ives.

Fred Walter McNair was born at Fennimore, Wis., December 3, 1862. He received the B.S. degree from the University of Wisconsin in 1891; Sc.D. from Lafayette College in 1907; Sc.D. from Rhode Island College in 1919. He was Assistant Professor of Mathematics at the Michigan Agricultural College, 1892–93; Professor of Mathematics and Physics, 1893–99, and President since 1899 of the Michigan College of Mines. He was a Fellow of the A. A. A. S. (Vice-President, Section D, 1905–05, Secretary of the Council, 1905–06, General Secretary, 1906–07). He was Vice-President of the Lake Superior Mining Institute, 1904–05; Member of the American Institute of Mining and Metallurgical Engineers; Mining and Metallurgical Society of America; American Physical Society; Consulting Engineer and Physicist, U. S. Bureau of Standards, 1918–20, Member of the Board of Visitors, 1920–. President McNair was Vice-President of this Society in 1902–03, President in 1904–05, Member of the Council since 1902. He was also a member of the Board of Investigation and Coördination. He had been a member of the Society since 1897.

John Hoffman Dunlap was born at Harrisville, N. H., September 9, 1882. He received the A.B. degree from Dartmouth College in 1905; C.E. from Thayer School of Civil Engineering, 1908. He was an Assistant on the Engineering Corps of the Pennsylvania Lines West, Columbus, Ohio, 1907; Field Instructor, Thayer School of Civil Engineering, 1908; Professor of Hydraulics and Sanitary Engineering, The State University of Iowa to 1922; Secretary of the American Society of Civil Engineers from June 1922–. Mr. Dunlap was a member of the New England Water Works As-

sociation, American Water Works Association, American Public Health Association, Proportional Representation League, New Jersey Sewage Works Association; President, Social Service League of Iowa City; Member, Executive Committee, Boy Scout Council, Iowa City. He was a member of the Board of Investigation and Coördination of this Society, having been reappointed in 1923 to serve for five years. He had been a member of the Society since 1916.

Frederick Walter Ives was born in 1884. He graduated from the University of Wisconsin in 1908 and served there as student assistant and instructor for one year in the Department of Mechanical Engineering. In 1909 he was instructor in Engineering Drawing at The Ohio State University and in 1914 was made Assistant Professor of Agricultural Engineering, assuming the head of the Department in 1920.

Professor Ives was elected President of the American Society of Agricultural Engineers at their annual meeting in Lincoln, Nebraska, in June, 1924. He was contributing editor for the Ohio Farmer and was also corresponding editor for Farm and Fireside. He was also an author of several books.

Professor Ives was a member of this Society since 1910.